(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE

140 NASSAU STREET, NEW YORK

J. S. BONSALL, Business Manager.
F. H. THOMPSON, Eastern Representative

R. V. WRIGHT, E. A. AVERILL, } Editors.

JANUARY, 1909

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It is beyond successful contradiction to say that any piece of machinery or apparatus will perform the work for which it is specially designed better than will some other machine or apparatus which was designed for a different purpose and has been adapted to this use. This is as true of a locomotive as any other piece of machinery, and there is no doubt that an engine designed especially and exclusively for use with oil fuel will give better results than a coal burning locomotive adapted for using oil. The important points of difference in the design of the locomotive boiler for use with these two fuels is discussed in an article by Harrington Emerson elsewhere in this issue. Mr. Emerson has had excellent opportunities of studying the service of oil burning locomotives, and especially those which were primarily designed to burn coal, and has been impressed with the extra expense in connection with the rapid renewal of fireboxes and flues that is required on such boilers. These locomotives on one road cost between 3 cents and 16 cents more per mile for maintenance than does the same engine when burning coal, which, with a locomotive making 30,000 miles per year, would give from $900 to $4,800 per year. It would seem to be worth while to use this amount for a boiler construction adapted for this fuel rather than for the maintenance of a locomotive designed to burn coal. In considering the subject, however, it should not be forgotten that the importance of having locomotives capable of using both fuels and thus available for use at different points on a large system may be greater than the expense of maintaining fireboxes.

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THE RAILWAY BUSINESS ASSOCIATION

The Railway Business Association (see page 431, November, 1908, issue) is doing a work that is deserving of the active support of every fair-minded man. The efforts of this association are directed toward the restoration of the purchasing power of railroads, which, as every one knows, has been practically exterminated during the past year. This condition is very largely due to the anti-railroad legislation of recent years, which has resulted in making investors apprehensive as to the security of railroad investments. This has, of course, practically destroyed the borrowing power and hence very largely the purchasing power of the roads and compelled them to stop all extensions and improvements. Furthermore, recent legislation has added greatly to the expense of railroad operation, while transportation rates, figured on a ton-mile basis, have been continually reduced, resulting in a narrowing of the margin between cost and revenue. This has become serious and it has become necessary to consider an adjustment of rates exactly as is necessary in all commercial enterprises involving increasing costs.

The members of this association, who represent a capital of about $500,000,000, and employ many thousands of men, believe the agitation should be stopped and the companies should be allowed to readjust themselves to the new conditions and give the new laws on the statute books a fair trial without further handicap. They believe that when the public is educated to view transportation problems without prejudice, agitation against railways will cease for lack of popular support, but meanwhile emergency measures are necessary to prevent further damage. The first effort of the association, and in this it has been surprisingly successful, has been to persuade boards of trade throughout the United States to pass resolutions looking to the discouragement of anti-railroad legislation. It has followed this by starting a campaign of personal demands upon legislatures with the same object and it is in this work that the readers of this journal can be of great assistance. The association is urging everybody to write to legislatures, both state and national, demanding calmness in legislation affecting railroads, and the results of its efforts give promise of the accomplishment of its object. To make the success more far-reaching for the future every one dependent upon railroad activity should join, individually, in raising a voice of protest to those who make our laws; furthermore, all companies manufacturing or dealing in railway supplies should, by all means, identify themselves with this association.

ROUNDHOUSE CONDITIONS.

An ideally operated roundhouse should have facilities for promptly handling the engines and keeping them in a first-class state of repair. By so doing, and replacing broken and defective parts at once, better service will be obtained and the mileage between shoppings will be greatly increased. Railroads are organized to sell transportation and any feature which will show decided advantages, tending to give better service and bring greater financial returns to the stockholders, should receive the support of the officers and boards of directors. Are the miserable conditions which exist on some roads due to a lack of foresight of these men, or is it because the motive power and operating officials have failed in impressing them with its importance? In some instances it would seem that the motive power and operating departments have been so busy trying to "knock" each other that neither one has had time or energy enough left to carefully analyze this subject as it should be.

While it must be admitted that much is still to be desired in designing and equipping roundhouses to better meet the severe conditions for which they are intended, especially in the northern districts, yet splendid progress has been made in this direction during the past eight or ten years. Those who are somewhat acquainted with the newer roundhouses and the results being obtained from them must receive a severe shock to find the most miserable roundhouse conditions imaginable existing on large and important systems. Houses which were inadequate, even for the times in which they were built, are being used, sometimes at important points. With the newer locomotives it is often necessary to keep the doors partially or entirely open when the engines are in the house. Turntables are in many instances still operated by hand and are in such poor condition that a large part of the roundhouse force is required to operate them during the winter. The coaling station, sand and water supply and the ash pits are arranged so that engines are frozen up before they reach the house, resulting in troubles too numerous to mention. Houses are so full of smoke, gas and steam that it is an outrage to ask men to work in them.

What is the result? Engines are poorly taken care of and are rarely ever ready for service, although they are sent out sometimes to fail miserably on the road; delayed trains and poor service; low mileage between shoppings and increased cost of maintenance. Whose fault is it? Is it reasonable to suppose that any intelligent board of directors would not take prompt action if they knew of these conditions and what it meant financially to the railroad?

LIFE OF SIDE SHEETS.

The great reduction in the life of firebox sheets on wide firebox locomotives, as compared with those in narrow fireboxes, is by no means a new problem, but that does not lessen its great importance. Mr. Seley in a paper before the Western Railway Club, given on page 20 of this issue, has elaborated a theory for explaining this condition, which seems to be very plausible. In studying the subject, he starts with the fact that a side sheet in a firebox 60 in. wide, having an ogee curve, will last on an average of 7½ years, while in a firebox 80 in. wide, with straight side sheets inclined inward from the mud ring on a locomotive operating in the same service, with the same feed water, and burning approximately the same amount of coal, though at a lower rate per square foot of grate area, they will only last three years, and incidentally will give considerably more trouble from leakage during that period than did the others. It is also known that steel will stand a certain number of stresses of any given amount, which number is varied in an inverse proportion to the amount of the stress. With these conditions as a basis, Mr. Seley presents the theory that the failure of the straight side sheets may be due to their attaining a higher temperature and thus becoming subject to a greater stress, which reduces the number of stresses they are able to resist, and that this increase in temperature is caused by the formation of a film of steam on the outside of the sheet, which prevents the water from coming in actual contact with the sheet and keeping it cooler. The reason the firebox with ogee sides is not subject to the same condition, he figures, is due to the fact that it has an outward inclination and that the circulation in the water leg impinges against the sheet, breaking up the film of steam and thus keeping it at a lower temperature. Further, the narrower water leg in these boilers increases the rate of circulation, and hence this impinging action, thus aiding in the same cause.

The facts in this case are beyond contradiction in most places, and certainly in those where the feed water conditions have remained unchanged since the introduction of the wide firebox locomotives. This condition was forcibly illustrated recently by the building of some large narrow firebox Pacific type locomotives for the Chicago & Alton, illustrated on page 399 of the October, 1908, issue of this journal, which had followed a long series of experiments with the two different types of fireboxes on that road.

If Mr. Seley's theory is correct, and it is the increase in temperature of the sheet that caused its early failure, it would seem that the remedy would be in the shape of some construction which would allow the free expansion of the sheet either in the form of vertical corrugations or provision at the end of the sheet for permitting its expansion. Both of these remedies are now being tried, the former quite extensively on one road. The matter of the narrower water leg has an objection in the reduction of the length of staybolts, but it probably does increase the rate of circulation and hence the steam capacity of the boiler. The objection to reducing the length of the staybolts could be overcome by the use of flexible bolts or some similar provision.

GOOD TIMES AHEAD FOR THE RAILROADS

What are you doing to help bring it about?

If you are a manufacturer or dealer in railroad supplies join the Railway Business Association, and PUSH.*

Whoever you are, sit down at once and write to your Senators and Congressmen at Washington and to your State legislators, asking them for calm and careful consideration of all legislation affecting railroads. Urge your friends to do the same.

"We want to put back on full time the plants which manufacture materials and equipment for railroads." Thus spoke an official of the Railway Business Association. "When other business picks up, we want our share. And if concerns which sell to railroads do not resume normally, other business cannot and will not become normal. The purchasing power of railroads can only be restored by strengthening their credit with investors. Investors can only be reassured by evidence that the public is ready to consider railroad legislation in a calm spirit. We are laboring to create and to crystallize public opinion favorable to moderation in the restriction of railroads, to acquaint legislators, national and state, with the existence of a widespread demand from business men for constructive legislation, and then to keep investors in touch with what is being done to safeguard their interests."

* * * * * * *

That the association is performing this work in an effective manner is evident in many ways. Railroad managers are expressing their hearty appreciation of the methods employed and the results obtained. Resolutions have begun to be adopted by important business bodies looking to legislative calmness; letters in large numbers are going forward from railroad material, equipment and supply manufacturers and other business men to legislators, and encouraging replies are coming back; all of which cheering news is contained in a letter just sent to members of the stock exchanges in the principal cities, asking them to let their clients know what is going on in this direction.

* * * * * * *

On December 7 the association issued a "Business Appeal to Business Bodies." This document set forth that the railroads were not buying material or equipment except in meagre quantities, and that manufacturing establishments depending upon the railroads have been wholly or partly idle for a year. "Many men," this circular pointed out, "are out of work, and the loss is extended to those who supply the necessities of life to the men affected." After explaining that the cost of constructing and of operating railroads had greatly increased, and that government officials have urged the railroads not to reduce wages, it was declared that two things are necessary: "First, moderation in legislation, for a while, to allow the great transportation industry to adjust itself to radically changed conditions due to recent enactments; second, an adjustment of rates to permit railroads to add to the price of service to cover increased cost of operation—exactly as do manufacturers and merchants." And the appeal concluded by asking the body addressed to adopt a resolution along the line indicated.

* * * * * * *

The response was immediate. On December 8 the Southern Commercial Congress, composed of delegates from 64 business organizations in 14 Southern States, adopted at Washington, D. C., a resolution declaring that the construction of transportation facilities adequate for developing the resources of the South "can be accomplished only by assuring the holders of capital that such enterprises will be safeguarded by conservative and constructive legislation, and we urge upon our Southern legislators the wisdom of such policy and condemn any agitation leading to the contrary." This was passed unanimously amid spontaneous applause.

* * * * * * *

The following day, December 9, the New York Board of Trade and Transportation unanimously instructed its committee on railway transportation to issue a resolution declaring it to be of "paramount importance to the commercial interests of our country that the earning power of our railroads shall not be reduced or their credit impaired by legislative acts and decrees of commissions," and deprecating "any action by business bodies, individual shippers or federal and state officials which may tend to aggravate public prejudice against railroads." The resolution also "urges the business men of the country to favor such freight rates as will insure the railroads adequate revenues for maintaining the equipment and roadbed and handling the traffic."

* * * * * * *

On December 21, the executive committee of the Merchants' Association of New York, a body which has several times given public expression to similar views, stated in a preamble that the purchasing ability of the railroads, especially that relating to new construction, is largely contingent upon their ability to make such new issues of securities as may properly be needed to cover their financial requirements, and the abiilty to do this is directly dependent in turn upon public confidence in the stability of the conditions which determine the earning power of the railroads." The resolution urges legislators and railroad commissioners "to encourage the return of railroad business to normal conditions by ceasing and discountenancing ill-considered or unjustified censure of existing methods of railroad management, and by limiting proposed new legislation on these matters to such measures as have been so carefully investigated and studied as to determine clearly not only the necessity for their enactment, but also their proper form and scope for the accomplishment of intended reforms."

* * * * * * *

Copies of these resolutions have been sent to hundreds of business organizations all over the country together with a second appeal to them to take similar action. Many such associations have notified the Railway Business Association that the matter had been referred to the committee charged with such matters, and vigorous efforts are being put forth, especially in cities where the Railway Business Association has members, to secure the adoption of resolutions.

* Address G. M. Basford, Acting Secretary, No. 2 Rector Street, New York City.

WITH THE RAILROAD CLUBS.

Canadian Railway Club (Montreal, Can.).—J. A. Kinkead, manager of sales for the Parkersburg Iron Company and formerly engineer of tests for the American Locomotive Company, will present a paper on "Springs and Spring Steel" at the meeting for Tuesday, February 2nd.

Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal.

Central Railway Club (Buffalo).—The annual meeting and banquet will be held at the Hotel Iroquois on Friday, January 8th.

Secretary, H. D. Vought, 95 Liberty street, New York City.

New England Railroad Club (Boston, Mass.).—The next regular meeting will be held at the Copley Square Hotel, January 12th. N. W. Storer, of the engineering department of the Westinghouse Electric & Manufacturing Company, will read a paper on "Single-Phase Railway Systems." Dinner will be served at 6:30 and the meeting will be called to order at 8 P. M.

R. D. Smith, assistant superintendent of motive power of the Boston & Albany Railroad, in his paper on "Terminal Facilities for Handling Locomotives," presented at the October meeting, considered, in more or less detail, the general arrangement of engine-house plants, as well as the design and construction of engine-houses and their equipment. General plans were shown of three new roundhouses on the Boston & Albany, at Beacon Park, Mass., West Springfield, Mass., and Rensselaer, N. Y. From the very thorough discussion which took place it would appear that there is a great need for better locomotive terminal facilities and that the railroads must awaken to the realization of the fact that the efficiency of the motive power depends largely on having proper engine-house facilities.

Henry B. Fletcher, architect of the Boston & Maine Railroad, in his paper on "Railroad Stations," read at the November meeting, described the various types, from the flag station to the large terminal station, and considered at length the requirements, as well as the best arrangements, for each class.

Secretary, Geo. H. Frazier, 10 Oliver street, Boston, Mass.

New York Railroad Club.—At the meeting for Friday evening, January 15th, J. E. Muhlfeld will read a paper on "The Education and Organization of Railway Engineering Labor."

The annual reports, presented at the October meeting, showed a membership of 1,420, with $14,450.48 in the treasury.

Secretary, H. D. Vought, 95 Liberty street, New York City.

Northern Railway Club (Duluth, Minn.).—Next meeting Saturday evening, January 23rd. Claude Richards, foreman boilermaker, C., St. P., M. & O. Ry., Itasca, Wis., will speak on "Boiler Repairs in the Roundhouse from the Standpoint of a Boilermaker." N. P. White, roundhouse foreman, N. P. Ry., Duluth, will speak on "Engine Repairs in the Roundhouse from the Standpoint of a Machinist."

At the annual meeting held at Superior, Wis., November 28th, one hundred and seventy-nine members were present with their wives. The annual reports showed that 244 members had been added during the year, bringing the total membership to 529. There was $588 in the treasury, with considerably more still due. The following officers were elected: President, J. W. Kreiter, supt., D., M. & N. Ry., Proctor, Minn.; vice-presidents, J. H. Hicken, chief dispatcher, Gt. N. Ry., Superior, Wis., and J. E. Goodman, div. supt. motive power, N. P. Ry.; treasurer, S. F. McLeod, purchasing agent, D., M. & N. Ry., Duluth; secretary, C. L. Kennedy, commercial agent, C. M. & St. P. Ry., Duluth, Minn.

This meeting was the third anniversary of the club. Dinner was served at 8:30. The business meeting followed, after which there was a short musical program, the rest of the evening being given over to dancing.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

Railway Club of Pittsburgh.—At the meeting for Friday evening, January 22nd, Wm. Elmer, Jr., master mechanic of the Pennsylvania Railroad, will read a paper on "Some Engine-House Auxiliaries."

At the December meeting Col. B. W. Dunn, chief inspector of the Bureau of Explosives of the American Railway Association, gave an illustrated talk on the proper way to handle explosives and other dangerous articles in shipment.

Secretary, C. W. Alleman, General Offices, P. & L. E. R. R., Pittsburgh, Pa.

Richmond Railroad Club.—Next meeting, Monday evening, January 11th.

At the annual meeting in November the following officers were elected: President, H. M. Boykin, division freight agent, Seaboard Air Line Ry.; first vice-president, E. H. Lea, agent, Southern Railway; second vice-president, A. H. Moncure, master car builder, R. F. & P. R. R.; third vice-president, W. H. Owens, master mechanic, Southern Railway; secretary and treasurer, F. O. Robinson, C. & O. Ry. The club has 236 members and a balance of about $1,650 in the treasury.

Secretary, F. O. Robinson, 8th and Main streets, Richmond, Va.

St. Louis Railway Club.—At the next meeting, January 15th, E. F. Kearney, supt. transportation, Missouri Pacific System, will address the club on "Ethics of Railroading."

Judging from the souvenir program of the Christmas Smoker, held December 11th, the members had a pretty lively time. Over five hundred were present.

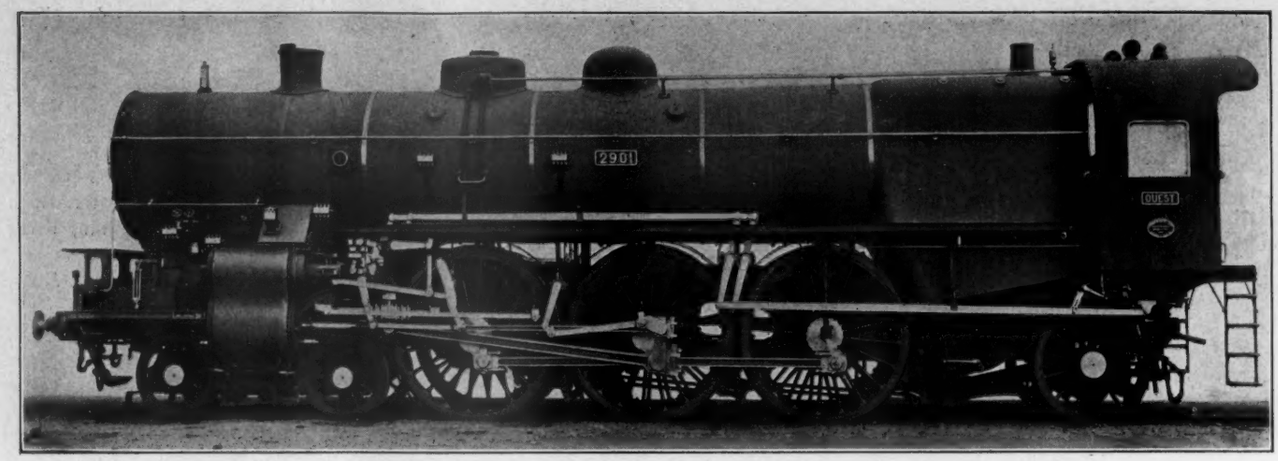
Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

Western Railway Club (Chicago).—At the next meeting, Tuesday, January 19th, Eugene McAuliffe, general fuel agent of the Rock Island Lines, and president of The International Railway Fuel Association, will address the club on "The Purchase and Handling of Railroad Fuel."

J. J. Hennessey, in his paper on "The Abuse of the M. C. B. Repair Card," at the December meeting, directed attention to the annoyance and expense caused by the non-application of repair cards. A portion of his paper appears on another page of this issue. C. A. Seley presented a paper on "Life of Side Sheets of Wide Fireboxes," suggesting a theory to account for the long life of the side sheets of the narrow firebox. This paper will also be found in this issue.

Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago, Illinois.

VALUE OF RAILROAD CLUBS.—Membership in such clubs as this, and kindred associations, is also a most fruitful method of obtaining information as to the progress of the profession not only from participation in the formal proceedings but in the chance to meet his colleagues, discuss his difficulties and take advantage of their ideas and impart his to them. The human mind is so constituted that often what may be a serious stumbling block for one individual will be readily solved by another of equal or even of inferior capacity.—*W. J. Harahan, before the New York Railroad Club.*



BALANCED COMPOUND PACIFIC TYPE LOCOMOTIVE.

WESTERN RAILWAY OF FRANCE.

The Western Railway of France has recently completed in its own shops two very large and powerful Pacific type passenger locomotives, which slightly exceed in total weight those recently put into service on the Paris-Orleans Railway (See AMERICAN ENGINEER, Sept., 1908, p. 339), and are believed to be the heaviest passenger locomotives in that country. They are of the four-cylinder balanced compound type, the cylinders being arranged, relative to each other, the same as on the Cole compounds in this country, *i.e.*, the high pressure cylinders are between the frames and located some distance ahead of the low pressure cylinders, which occupy the same position relative to the engine truck and stack as do the cylinders of the simple locomotive. The high pressure cylinders drive on the first driving axle, which is cranked, and the low pressure connect to the second pair of drivers. This arrangement of cylinders is different from what has heretofore been used in France on four-cylinder compounds and was caused by the large diameter of the low pressure cylinders making it impossible to conveniently locate them between the frames. Since they must be placed outside it is preferable to have as direct passage as possible to the exhaust nozzle which locates them over the center of the front truck. This location also improves the distribution of weight. The high pressure cylinders are then set sufficiently far ahead of the front drivers to give a satisfactory length of main rod.

The arrangement of the valve gear is very unusual, being so constructed that both sets of gears on each side are operated entirely from a return crank on the second pair of drivers. The eccentric rod from the usual return crank pin drives the outside link in the ordinary manner, and the inside link through a rocker extending over the guides and frame, as is shown in the illustration. The combination levers are not connected to the cross heads as is usual, but are driven by an extension on the return crank, which carries a pin 180 degrees from the main crank pin, from which a rod extends to a rocker located between the first and second pair of drivers. From this, inside and outside, there are rods connecting to the ends of the combination levers. The outside gear is arranged with the combination lever extending downward in the usual manner and the inside gear has it extending upward. The reversing mechanism is separate for each of the two sets of gears, having two reach rods and two sets of power reversing gear, both located on the left side. This arrangement gives a valve gear that is practically all on the outside of the locomotive, and allows the elimination of eccentrics on the cranked axle, the latter being the controlling reason for arranging it in this manner. Eccentrics on a cranked axle must of necessity be very narrow and compel the use of a narrower driving journal than would otherwise be desirable. With this arrangement the journals can extend practically to the face of the cranks, giving a liberal bearing, and the crank pin can also be allowed a wider surface. The inside and outside cranks on the same side are set 180° apart.

The guides, as well as all of the valve gear mechanism in the vicinity of the cylinders, are supported by a single large steel casting which extends over and between the frames just ahead of the forward driving wheel. The guides are of the single bar type, the inner pair being supported directly between this steel casting and the H. P. cylinder heads. The position of the outside guides is such, however, that the supporting casting comes opposite their center, and they are supported at either end by another steel casting, which shows in the illustration, being connected to the back cylinder head and the guide yoke or casting and extending far enough to the rear to carry the reversing link.

The frames are of the plate type and are securely braced and stiffened by vertical stiffeners between each set of drivers as well as a very substantial cross bracing for both the horizontal and vertical direction, just in front of the fire box. The cast steel guide yoke just mentioned also acts as a valuable frame brace and stiffener and in connection with the H. P. cylinder castings and the saddle gives a very rigid and strong construction at the front end. The driving springs are overhung, being located just inside the frames and above each journal box. The system of equalization on each side includes the trailing truck, giving a three point suspension for the whole locomotive.

The coupling between the locomotive and tender has been given careful attention, because of its distance back of the rigid wheel base of the locomotive, which gives it a large lateral movement. This movement has been cut down as much as possible by bringing the buffer forward underneath the cab for a considerable distance and provision has been made for the lateral displacement of the tender underframe by using a front tender truck fitted with swing links.

The boiler is of the Belpaire type, telescopic in the arrangement of the barrel sheets, being about 63½ in. in diameter at the front end. Its center is raised sufficiently high to give a deep throat without an excessive slope to the grate. The fire box extends over the frames, giving a grate 5.9 ft. wide and 7.32 ft. long. The back head is sloped from the mud ring to the level of the crown sheet, above which point it is vertical, being stayed by rods which extend forward and connect to the barrel with two exceptions, which are continued forward to the front tube sheet. The tubes, 19 ft. 8 in. long, are of a smooth type, Serve tubes not being used because of the extreme length. The dome is located on the center of the three barrel sheets and contains a balanced throttle valve, taking steam from the top only. The heating surface, grate area, etc., are given in the table of dimensions. The front end, which it will be observed is extremely long, contains a re-heating drum or receiver, into which the steam from the high pressure cylinders is exhausted and from which the supply to the low pressure cylinders is taken. This drum is not very large and is secured in a longitudinal position at the top of the front end ahead of the stack. The pipes leading to and from it, however, give considerable heating surface and the result, no

doubt, will be at least perfectly dry steam for the L. P. supply.

The design of the trailing truck, which has inside journals, is interesting. It is of the radial type, both journal boxes forming part of a single casting that is continuous over the axle and includes the radius bar. The weight is transferred from each journal box through two swinging links to a casting which forms the guide for the boxes and is itself in turn guided by the jaws of the pedestal, thus having motion only in the vertical direction. The semi-elliptical springs are carried from the bottom of this casting, being connected to the equalizers at one end and the frame at the other.

As can be seen, a speed recording apparatus is applied, being driven by a gear from the back driving axle. The indicating pointer is located in the front wall of the left side of the cab or directly in front of the engineer, who sits on the left-hand side. All of the controlling gear of the locomotive is arranged in front of the driver, the reversing gear being controlled by a hand wheel arranged like the steering gear of a motor car, *i. e.*, vertical instead of horizontal, and operates either or both sets of valve gear, as desired; the throttle lever projects down alongside of the fire box, within convenient reach of the right hand; the simpling valve, brake valve, sanding apparatus, blow-off cocks (operated by compressed air), etc., are located at convenient points in the same vicinity. The appliances operated by the fireman are placed on the right hand side.

The ash pan is divided into three parts by longitudinal partitions and is fitted with one inner and two outer doors, which insure a proper distribution of air underneath the grate.

The facts concerning this locomotive have been drawn very largely from a very complete descriptive article in the *Revue Generale des Chemins de Fer.*

Some of the more important general dimensions and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. coal
Tractive effort	27,874 lbs.
Weight in working order	200,000 lbs.
Weight on drivers	118,020 lbs.
Weight on leading truck	49,380 lbs.
Weight on trailing truck	32,600 lbs.
Wheel base, driving	13 ft. 3 in.
Wheel base, total	34 ft. 6 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.25
Total weight ÷ tractive effort	7.18
Tractive effort × diam. drivers ÷ heating surface	700.00
Total heating surface ÷ grate area	70.00
Firebox heating surface ÷ total heating surface, per cent	4.93
Weight on drivers ÷ total heating surface	39.00
Total weight ÷ total heating surface	66.00
Volume equiv. simple cyls., cu. ft.	10.00
Total heating surface ÷ vol. cylinders	302.95
Grate area ÷ vol. cylinders	4.32
CYLINDERS.	
Kind	Bal. comp.
Diameter and stroke	15¾ and 26 x 25.2 in.
Kind of valves	Piston
WHEELS.	
Driving, diameter over tires	76¼ in.
Engine truck wheels, diameter	37.8 in.
Trailing truck wheels, diameter	51½ in.
BOILER.	
Style	Belpaire
Working pressure	228 lbs.
Outside diameter or first ring	63 in.
Firebox, length and width	87.84 x 70.8 in.
Tubes, number and outside diameter	283—2.16 in.
Tubes, length	19.6 ft.
Heating surface, tubes	2880 sq. ft.
Heating surface, firebox	1495 sq. ft.
Heating surface, total	3029.5 sq. ft.
Grate area	43.2 sq. ft.
Center of boiler above rail	114.1 in.
TENDER.	
Weight, light	53,000 lbs.
Water capacity	5,280 gals.
Coal capacity	9 tons

THE EMPLOYMENT OF MEN.—One of the most important duties of an officer entrusted with it is the employment of men, and it is one which he should weigh well, and, should seriously appreciate the gravity of. In hiring the inferior grade of employees he should reflect that he is hiring the future section or shop foreman, the future dispatcher, the future engineer, the future conductor, and if the true principle is carried out the future officer of whatever grade; it therefore requires rare discrimination to do that which is the proper thing.—*W. J. Harahan, before the New York Railroad Club.*

RESULTS OF OPERATION OF THE ELECTRIFIED SECTION, N. Y., N. H. & H. R. R.*

W. S. MURRAY.

The duty assigned to the engineers of the New York, New Haven & Hartford R. R. was to provide for the electrical operation of their trains. At the early period of April 1, 1905, when we settled down to this responsible task, the data in the field, upon which to base real conclusions, were about 5 per cent, in comparison with the experience now available. To those who may be interested in my conclusion in regard to the electrification, I can simply say that if I was in favor of the use of the present system three years ago, that now, standing on the more stable ground of experience, particularly in regard to the department of faults, I am doubly in favor of it.

In the conception of the form of power house, line, and locomotive to be used on the New Haven system, those pertinently interested in its success believed that while the chain of power generation, and its transmission and utilization for traction, was of a new character, its links, however, were made up of principles long recognized and reliable. They were right in this conclusion, except that it did not include certain phenomena which could not have been anticipatd, due to the combination of these old principles in the form of this new chain. For example, there was nothing particularly disturbing about an 11,000-volt 25-cycle, three-phase power house from which was to be taken most of the power from one of the phases generated; or of a 300-ft., 11,000-volt, single-phase transmission line, from the terminals of which the same voltage was to be distributed, east and west, along the right-of-way of a railroad; or of a locomotive with a transformer installed upon it to take 11,000 volts and step it down to 600 volts to supply 300-volt single-phase railway motors. Power houses of this character have been designed the world over, except perhaps that single-phase current in the amount to be utilized had not been used elsewhere. Transmission lines of 60,000 volts had been in constant use. And except that there was a moving contact in connection with the current that was to go to the step-down transformers on the locomotives, transformers of many times the capacity and voltage were in universal use. The single-phase motor indeed, may be said to have been new so far as the size required for the New Haven service is concerned, but tests made upon smaller units demonstrated beyond peradventure its tractive qualities and showed its characteristic curves to be closely similar to those of its prototype, the direct-current motor.

This reasoning, in close consideration of each class of apparatus, *per se,* proved itself correct, and such irregularities as have existed in the initial electric service, which the New Haven road offered to the public have been due to the ramification of a series of faults that have developed entirely outside the zone of previous experience. The delays (and public criticisms of them) have followed even into this late day, when the electric service is far better than the steam service it has replaced. It has occurred to me that certain engineers, who are unbelievers in the single-phase system, may interpret this paper as an apology. To them I would say, as I do to the public, it is an apology for having delayed any of their appointments. To others, it is needless to add that the citation of these troubles is given in the hope that they will, as they easily can, avoid them in the future.

POWER HOUSE.

The electric power supply for the New Haven road is derived from four 11,000-volt steam turbine generators, three of which have an electric capacity of 3750 kilovolt-amperes single-phase; the fourth unit consisting of a 6000 kilovolt-ampere, three-phase generator which can also supply single-phase current to the system. Although the generators as originally designed were made exceptionally strong, and particular attention paid to their insulation due to the necessity of grounding one phase it was found that the utilization of so much single-phase current from a three-phase star-wound generator produced a stray magnetic field com-

* From a paper presented before the Amer. Insti. of Electrical Engineers.

pletely out of the path of normal lamination. As a result is was impossible to develop for continued operation more than 66 per cent of the normal rating of the generators. Overloads of any character produced abnormally rapid heating, making such operation dangerous, although the generators were guaranteed to carry 50 per cent overload for two hours, and 100 per cent overload for two minutes in order to meet the sudden drafts of currents required for a schedule such as exists on the New Haven road. Indeed, at the very start the actual drafts of current showed that the generators must meet imperatively the guarantees as to normal and overload capacities if the electrification was to be successful.

I trust it is not to be my pleasure to meet the prophet, who says, "This could have been anticipated." Suffice it to say that after three unsuccessful attempts at complete correction, each, however, affording some constructive results—months being absorbed in the dismantling and readjusting of the parts of these generators—the final attempt was successful and the generators are to-day operating in the power house, fulfilling the guarantees mentioned previously. But this last mentioned fact is insignificant when compared with the valuable information that has been derived, which will permit all other generators to be manufactured without the fault described.

Line Insulation.

The years of experience which we have had in the study of insulating various voltages led to what was considered a very conservative insulation in the various parts of the line. Messenger cables had to be insulated from the intermediate trusses and at their anchor-bridge termini. The trolley copper conductor was suspended from the messengers and had to be insulated at points where it entered the oil switches on the anchor bridges. Trolley wires had to be insulated from each other at section breaks. On curves both messengers and trolley wires had to be strained over the center of the tracks through the agency of pull-off posts at the side of the tracks, the pull-off wire being insulated between tracks and the pull-off column itself. Feeder wires had to be insulated from their supporting cross-arms and at points where they pass under highway bridges. None of these problems in insulation had the appearance of an especial character and indeed, did the roadbed provide traffic only for electric trains the problem would have been simplicity itself. A pressure of 11,000 volts being the prevailing dielectric strain, the problem was to provide sufficient insulation at all the points mentioned above.

Of the effect of steam locomotive discharges upon insulators, there was no initiative by which to be guided, and it became necessary to decide upon the factors of insulation that would be required. It was thought that ample provision had been made; it proved otherwise. Experience has proved that, in places, just double the amount is required. It was quickly noted that the greatest number of insulator failures occurred wherever the insulation was subject to the direct blast of the steam locomotive. To correct the difficulty, therefore, it was found necessary to double up on anchor insulators. The intermediate messenger insulators proved adequate and it was not found necessary to increase the impregnated stick insulation between trolley wires at curves, but wood stick insulators had to be added in series with the moulded material insulator between the pull-off wire and pull-off post. The original insulators on the anchor-bridge switches were made of moulded material and for them was substituted porcelain. It was not necessary to change the feeder insulators on the catenary bridge struts. While very little trouble has been experienced with the form of insulation used for supporting the feeders under highway bridges it is anticipated that trouble will follow if this is not changed. The present form consists of the corrugated spool-type insulator, for which there will be substituted a regular porcelain double-petticoat insulator. To-day instead of line failures being the rule they have become the exception.

Circuit Breakers.

The momentary energy involved in a short-circuit produced upon a line fed by high power high speed turbines is very great. Under the subtitle "Power house" it has been stated that the generators were operating under their guaranteed capacities. Internal heating, due to stray magnetic field, was the cause of the generators failing to meet their designed capacity. This heating was completely cured by the simple addition of a short circuited winding surrounding the rotating member of the generator, similar to that used in the well-known squirrel cage type of induction-motor rotors. It is interesting to note here, however, that while the heating is entirely eliminated by this short circuited winding, its effect on the occasion of a short circuit is to allow more current to flow. This tendency, however, is controlled by a method later to be described. In the New Haven system, as the current from the power house was fed directly to the line and from there to the locomotives without transformation of voltage by transformers, the inductive element to counteract the surging current was practically negligible; under these conditions there resulted short circuits which no circuit breaker apparatus then designed could be relied upon to take care of.

The failure of circuit brakers, either in the power house or on the line, naturally produced train delays of large or small magnitude. It was difficult to believe that these large circuit-breakers were incapable of taking care of the short circuits, and some time was wasted in thinking this way. Therefore, we reluctantly but surely arrived at the conclusion that the conditions would have to be changed.

The remedy was simple. Instead of feeding the main line with a direct transmission straight from the power house busbars to the trolleys directly opposite the power house, the current was fed into the line over feeders connected to it at Port Chester and Stamford. By the introduction of this ohmic resistance, amounting to not more than 2 per cent normal drop on the system, we were immediately released from the disastrous effect of short circuits on our circuit breaker apparatus. Instead of losing as many as half a dozen circuit breakers in a day, not that many were reported out of commission for a month, and, of course, they were not damaged to the extent of the others nor did they cause any serious delays.

For the feeder resistance, above described, there has since been substituted impedance coils installed in the leads of the generators. These coils act as shock absorbers, protecting the generators. Later, it is to be expected that there will be installed a circuit breaker across the terminals of these impedance coils, which, for normal operation, will shunt the current through them, the breakers opening under stress of abnormal flow of current and automatically closing when normal conditions are restored.

Trolley Wire.

In the month of May, 1908, it became evident to us that within at least one month from that date, if some change were not effected in the contact wire, that the New Haven electric service would cease. While this truth was so plain, it may be best described by the fact that daily reports were showing that the copper trolley wire was breaking at various points; and where it was not broken it had become so badly kinked at the hanger points that it was impossible to operate electric locomotives upon the line without serious arcing. This resulted in violent surging on the locomotive transformers, and, at times, on account of the extremely poor contact of overhead shoes on the line, in reducing the voltage to such a low value as to prevent a sufficient supply of power to enable the locomotive to perform its schedule. An examination of the hard-drawn copper trolley wire throughout its length proved that even after only a few months' operation upon it, its cross-section had been so materially reduced as to point to its short life with a continuance of operation upon it. Especially was this true in the vicinity of the many low highway bridges where the trolley wire approaches the bridge on a two per cent gradient. This fault and dilemma were indeed serious. The cause of the difficulty was perfectly apparent; namely, the hard spots in the line which existed at the hanger points.

Many suggestions were offered. None of them, however, offered the speedy installation that was paramount. Mr. McHenry, vice-president of the New York, New Haven & Hart-

ford Railroad Company, made the suggestion that an auxiliary wire be suspended from the present copper wire by clips at its midpoint between the hangers, and followed up the suggestion that this auxiliary wire be made of steel, of the same cross section as the 0000 grooved hard drawn copper above it. It took two weeks for the manufacturer to draw two miles of this wire. It was installed immediately upon its receipt on the main line between Port Chester and Harrison. On the night of its completed erection a special seven-car train with two locomotives was operated upon it for several hours. Previously to the installation of the steel wire there had been installed a section of hard alloyed wire suspended in a manner similar to that of the steel. The electric train was operated upon them both, officials from both the railroad company and the contracting company being on hand to note their comparative merits.

It was the general consensus of opinion that there was less sparking on the hard wire, and the general tendency was towards adopting that rather than the steel. Though admitting that the operation was better, the steel seemed to be of an entirely satisfactory commercial nature, and all present finally concurred in this conclusion. It is undeniably true that hard alloyed wire would, from a purely operative point of view, be the better of the two, and yet the commercial aspect, which would naturally include its cost, had to be considered, particularly in reference to so large an immediate order as one involving 100 miles of single-phase electric trackage. Again it is important to note that the steel, besides having the advantage of being a cheaper, harder, and stiffer wire, also possesses a lower coefficient of expansion and higher elastic limit, especially valuable characteristics for the service desired.

The auxiliary wire construction on the main line, as described, prevails throughout the whole system, except at the approaches of and under a few very low highway bridges, where the contact system consists of two wires strung in the same horizontal plane. The New Haven trains have been operating now on the auxiliary wire for several months, and absolutely no kinking has been noted at the hanger points, with the attendant result of a smooth and almost sparkless overhead contact.

LOCOMOTIVES*

There were originally purchased 35 locomotives, which was considered an adequate number to take care of the passenger service. These locomotives, considered *per se*, were rated on a half-unit basis. That is to say, the half unit was designed to handle about 75 per cent of our trains, the remaining 25 per cent to be handled by two units. Only a short experience in commercial operation revealed two important facts. The first one of a very encouraging nature, the second, decidedly otherwise. The first was the proof that the two main parts of the locomotive; namely, the transformer and motors, had sufficient capacity to more than handle the manufacturer's guarantees. The second was the discovery that many of the auxiliary electrical and mechanical parts of the locomotive equipment were not of equivalent capacity. The strength of the chain being measured always by its weakest link, it was immediately seen that the locomotives would be able to handle trailing loads in excess of their guarantees if the auxiliary parts were made of sufficient capacity to furnish the necessary current for the overload conditions. It was simultaneously apparent that more locomotives would be required to provide for an increase of train service and the reduction of time schedule, and an order was promptly placed for six additional ones. Before accepting their design, however, a careful survey was made of all the component parts of the locomotives at hand, in order to determine the changes necessary to be incorporated in the six new engines. To accomplish this it was found necessary to make a number of electrical and mechanical changes.

The most important electrical changes made were in the switch groups and brush holders of the motors. The former lacked carrying capacity and the latter sufficient insulation. To these shortcomings were due the greatest number of our first train delays. The most important mechanical changes necessary were the reinforcement of the truck bolsters and installation of pony wheels. The especial reference to these electrical and mechanical changes must not be construed as diminishing in any way the force of necessity of the others, as they were all considered absolutely necessary in order to preserve a low cost of electrical and mechanical maintenance.

With the exception of the installation of pony trucks,† the six new electric locomotives arrived within five months of the date of their order. To be noted here is the marked value of the spring type of armature and field suspension begun with the New Haven locomotive motors, thus making flexible the entire motor suspension. Indications already predict that this arrangement in combination with the pony trucks will reduce materially the track and locomotive maintenance and repairs. Today the reconstruction has been effected on over 90 per cent of our locomotives. This last and serious fault with which we had to contend completes the major difficulties that were constantly threatening the regularity of electric service.

It seems to be the time and place, here, to draw attention to a point in design concerning the New Haven locomotives that has been so persistently misrepresented by those who seem to have been ignorant of the facts. The specifications upon which the locomotive units were purchased, as stated hereafter, were that each unit would handle a normal trailing load of 200 tons. The writer, by careful measurement of the weights of all the trains (trailing loads) in the New Haven service, found that they averaged 212 tons. It seemed good engineering that if 75 per cent of the service could be handled by locomotives rated upon a basis of 200 tons trailing load, that that would be the correct locomotive unit size; using two units for the remaining 25 per cent of the trains. Today, three years after this decision, we find that 72 per cent of our trains can be handled with single units, 27 per cent requiring two units. The percentage is slightly different from the original, as the service is slightly heavier.

LOCOMOTIVE CURRENT COLLECTORS.

An efficient pantagraph shoe has proved itself a very difficult problem. The present cost is about .06 of a cent a locomotive-mile. We have made various experiments with aluminum, phono, copper, and steel rigid and spring-supported pantagraph shoes. While this feature does not present a serious aspect, it is none the less a most interesting study. Shoe life is also seriously affected by the amount of soot deposited by the locomotives upon the overhead wire. While we have obtained mileages varying between 600 and 1500 miles per shoe with various types used, other roads of lesser speed and not subject to the effect of locomotive stack discharges, have obtained as high as 25,000 shoe-miles.

THE POOR ROUNDHOUSE FOREMAN.—I doubt if there is any more abused individual than the engine-house foreman. It seems to be his lot to receive complaints, knocks when they get worse than complaints, from his superiors, from the engineers and firemen and from everybody anywhere nearly connected with the movement of trains or power. If there is a delay the engine-house foreman is held responsible, whether he is responsible or not. Sometimes it is practically impossible to get the power into the house. That makes no difference, the engine-house foreman gets it just the same. The master mechanic relieves himself of the responsibility largely by throwing it on to the engine-house foreman. The engineer, in the case of any delay occasioned by repairs or getting engines out of the house, will throw it on to the engine-house foreman. I said some months ago when this question came up that I believed that the most important individual on a road was this same engine-house foreman, and I have to further add to that, that he is the most abused.—*W. B. Leach before the New England Railroad Club.*

ENGINE FAILURES AND ROUNDHOUSE SERVICE.—It is the place to stop engine failures on the road, and good roundhouse service will be quickly reflected in better train movements and in reducing overtime on the road.—*R. D. Smith before the New England Railroad Club.*

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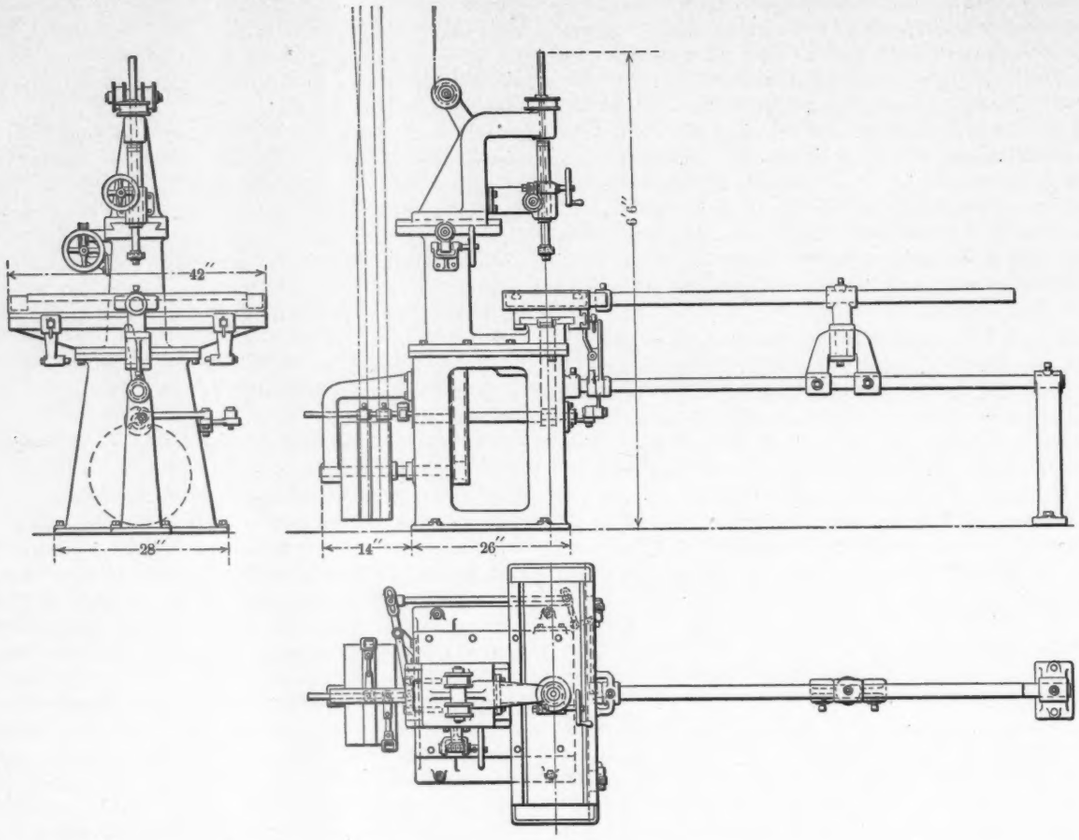
* See AMERICAN ENGINEER, Oct., 1907, page 397.
† See AMERICAN ENGINEER, Dec., 1908, page 489.

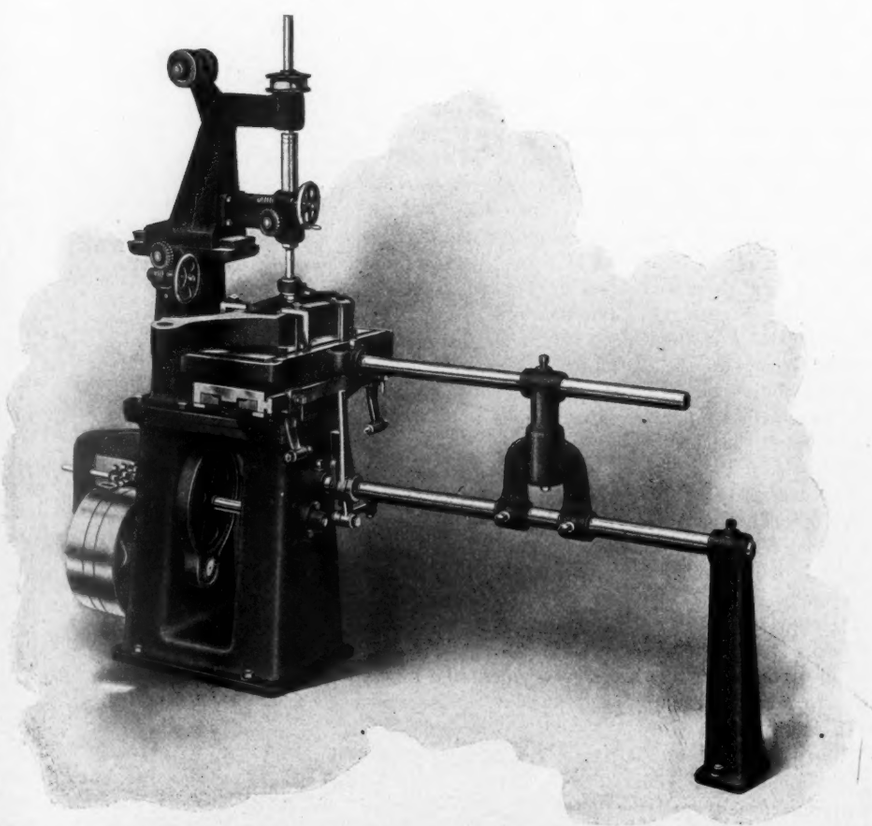


RADIUS GRINDER FOR VALVE GEAR LINKS.

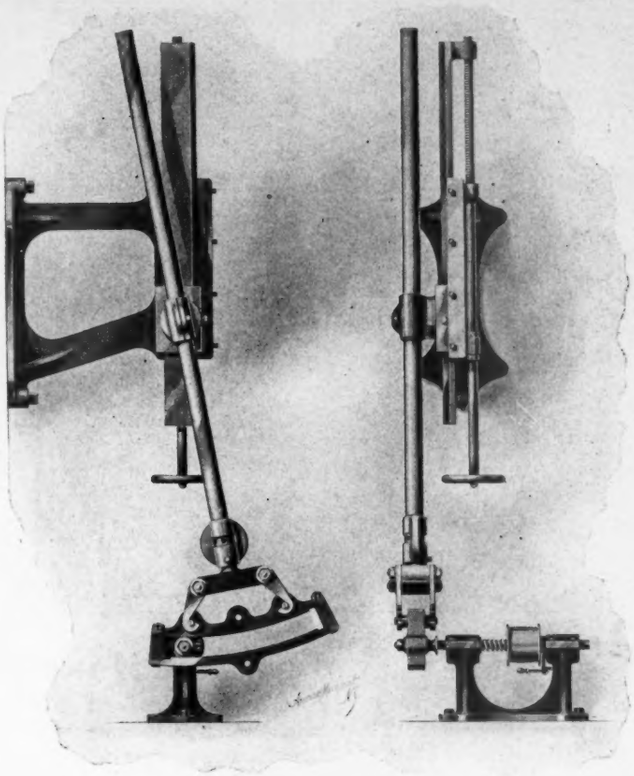
LINK GRINDERS.

The advent of the Walschaert valve gear has made it necessary to devise a machine for grinding and truing up the links, the devices ordinarily used for the Stephenson links not being suitable. A simple and substantial machine, especially adapted for this purpose, as well as for any radius grinding, and which may be readily converted into a surface grinder, is shown in the illustrations. To give some idea of the efficiency of this machine, a worn Stephenson link with a slot 18 in. long and 2¼ in. wide, was trued up in 35 minutes actual grinding time, exclusive of the time required to place the link on the table and adjust the machine. After the link was trued, 1/32 in. was ground off one side of the slot in 45 minutes.

The machine has two tables, the lower one being driven by a gear and rack and having an automatic reverse motion actuated by the same method as used on an ordinary planer. The length of the travel is adjustable, the dogs, which control the shifting mechanism, being clearly shown in the illustrations. The upper or floating table receives its motion from the lower table by means of a pivot block, which fits in a slot on the upper table; the radius described by this table is governed by the position of



RADIUS GRINDER SPECIALLY ADAPTED FOR GRINDING THE LINKS OF THE WALSCHAERT VALVE GEAR.

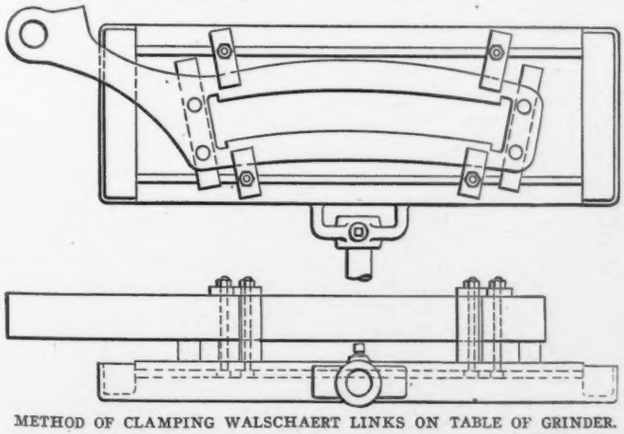


LINK GRINDER FOR STEPHENSON LINKS.

the swivel bracket on the radius bar. This radius bar is ordinarily furnished about 7 feet long, although it may be made longer if desired. The radius bar has graduations every 3 in., and by using a scale in connection with this, it is possible to quickly and accurately adjust it for any radius.

The work is placed on parallel strips and is clamped to the table, as shown in one of the sketches. If a large number of the links to be ground are of a standard design the setting of the work may be greatly facilitated by providing a special chuck for these. Link blocks may also be easily clamped to the table and ground.

Vertical and horizontal motions to the grinding wheel are obtained by means of the two hand wheels. The machine may be converted into a surface grinder by removing the radius bar and inserting an additional pin, thus fastening the two tables together. The upper table is 36 in. long, exclusive of the end pockets, 14 in. wide and has two "T" slots for 5/8 in. bolts. The floor space required, exclusive of the radius bar, is 4 ft. 4 in. by 3 ft. 6 in. The machine weighs 2,200 lbs. and is manufactured by H. G. Hammett, Troy, N. Y.



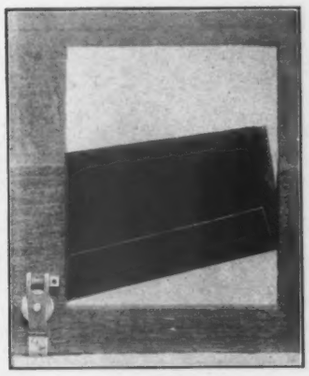
METHOD OF CLAMPING WALSCHAERT LINKS ON TABLE OF GRINDER.

For a number of years Mr. Hammett has also manufactured a link grinder, which is especially adapted for grinding Stephenson links. As shown in one of the illustrations, it consists of a wall bracket at the end of which is a long vertical bar upon which the carriage, carrying the pivot upon which the radius bar swings, may be adjusted. The grinding wheel frame is placed on a bench. The link is hung on the two hooks, as shown. To make sure that the bolts which these hooks engage are centrally located in the holes, taper washers are used and these are bored 1/32 in. off center, making it possible to adjust for uneven wear in the link, or warping due to case-hardening. The operator swings the link back and forth and by means of the small lever, underneath the pulley on the grinder shaft, works the grinding wheel sidewise, thus grinding the link evenly. The radius bar is adjusted by means of the large hand wheel, and a slight adjustment may also be obtained by the sleeve just above the hooks which engage the link. Arrangement is also made for taking up the wear of the wheel without affecting the radius of the work. The link blocks may also be ground on this machine.

METAL GRAIN DOOR.

The railroads are under a heavy expense in maintaining grain doors on box cars. The temporary wooden doors, in general use, are often broken while being removed, or are not replaced on the car after it is unloaded, or are lost in transmission. The shippers often use heavy spikes for holding the doors in place, and it is not unusual for the door posts to be injured in prying the doors off at the elevators. More or less time, often as much as thirty minutes, is required in loosening and raising the grain doors at the elevators. Knot holes in the wood and opening of seams in the door under a heavy load are responsible for the loss of considerable grain, especially while the cars are being switched.

The logical solution would seem to be to have a substantial door, preferably of steel, which would be a permanent fixture

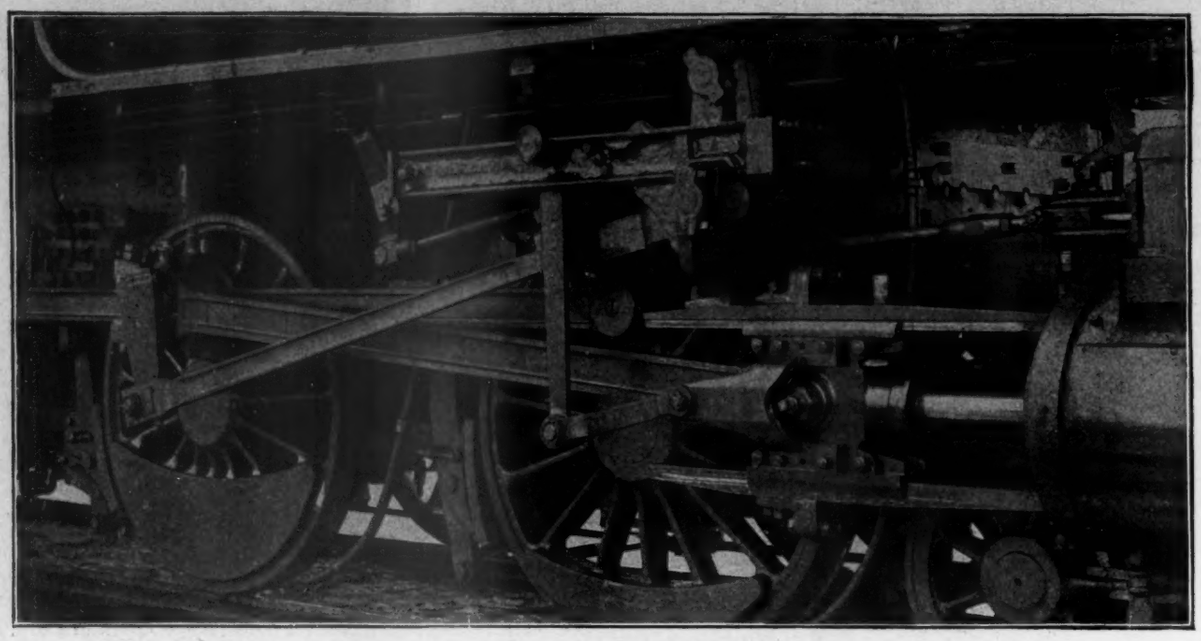


and be controlled by some mechanism by which it would be possible to easily and quickly raise the door.

The grain door, shown in the illustration, was devised by J. B. O'Neil and M. Voorhees, general foreman of the C., R. I. & P. Ry. at Peoria, Ill. It consists of two parts, the lower or smaller part being made of 5/16 in. boiler plate and the upper part of 3/16 in. steel reinforced on the inside by two 1¼ in. angle irons. The small door is controlled by a 2 in. shaft, to which it is securely attached, and which is operated through a worm and worm-wheel by an 18 in. bar or crank on the outside of the car. The lower door is first raised about 10 in., allowing the grain to start running and cave away from the top part of the door, after which both doors are raised and turned back flush with the door post, where they are practically locked in position.

In tests recently made at the Central City elevator in Peoria the door of a car was raised and the unloaders were in the car in four minutes.

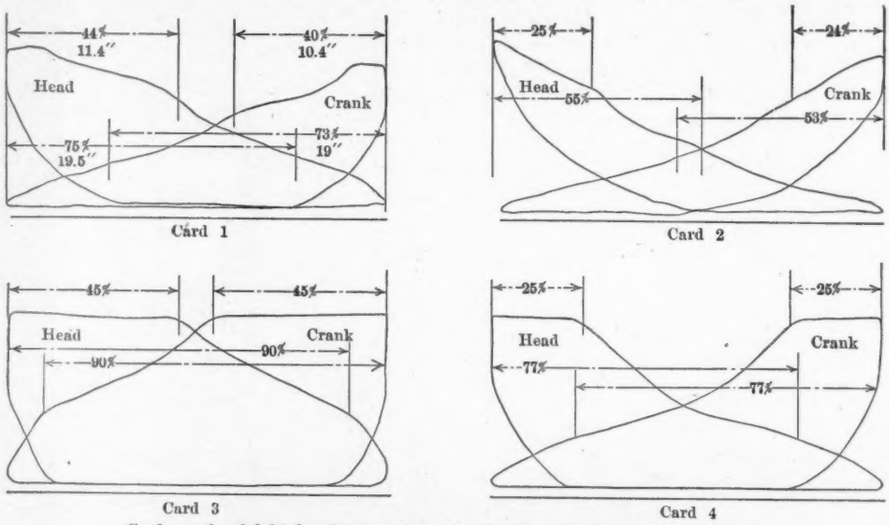
ROUNDHOUSE FACILITIES.—A good roundhouse foreman and a good yard master can go a long way towards running a railroad, but neither of them can do very much unless he has men and facilities to work with.—*J. A. Droege before the New England Railroad Club.*



APPLICATION OF THE BAKER-PILLIOD VALVE GEAR.

BAKER-PILLIOD LOCOMOTIVE VALVE GEAR

During the past four or five years more attention has been given to the proper movement of the valves of the locomotive for obtaining a greater economy, both of steam and maintenance, ease of action of the locomotive as a whole and simplicity of construction than was the case during its entire previous history. In this time a number of valve gears, which offered improvements in one way or another over the previously standard Stephenson gear, have been introduced and are being given extended practical trials on a large scale. Among these, of course, the Walschaert valve gear has passed beyond the experimental stage and is now the most popular gear for heavy power. Other valve gears, notably the Young and the Alfree-Hubbell, are being used to some extent very successfully. The latest development in this field is a new gear which, during the past year, has been applied to a number of locomotives with results that seem to indicate it will fulfil all the claims of its inventors. This gear is called the Baker-Pilliod and is shown in the accompanying illustrations. It is being applied on various railways throughout the country, notably on the Chicago & Alton, where, after a careful trial, it has been specified for use on twenty consolidation, five Pacific type and five six-wheel switching locomotives now being built by the American Locomotive Company.

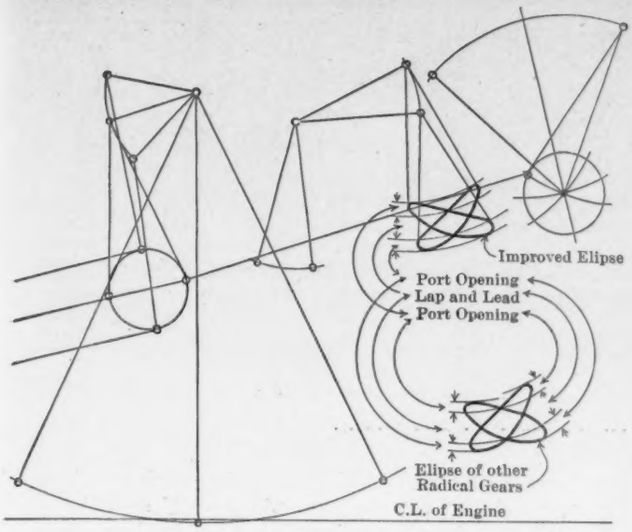


Cards number 1 & 2 taken from engine equipped with the Walschaert Valve Gear
Cards number 3 & 4 taken from engine equipped with the Baker-Pilliod Valve Gear

The mechanical construction of the gear consists of a return crank, from the main crank pin, similar to a Walschaert gear, but having considerably less throw. From this the eccentric rod transfers the motion to the point A, where a link is connected from a bell crank having unequal arms, which is operated from the cross head. This combination of motions gives the point A a circular or elliptical path, depending on the ratio of the arms of the combination lever bell crank. From A the continuation of the eccentric rod is carried to the point C, which is supported by a link swung around the point D, which in turn is swung around the point G by the movement of the reverse lever. When the gear is set, the point D is stationary and the point C follows a radial path, the location and inclination of which depends upon the location of the point D. Thus the link between A and C is given a circular or elliptical motion at one end and a radial motion at the other, which combined gives point B, from which the movement of the valve is taken, a distorted elliptical path, the shape, size and location of which depends on the movement of the point C, and thus the position of the reverse lever. The motion from point B is transferred from the vertical to the horizontal direction by means of the bell crank fulcrumed at E, the downwardly extending arm of which, as is shown in the illustration, operates the valve stem.

All of the motion is carried in a cradle similar to that often used in Pacific type locomotives equipped with Walschaert valve gear, which, in this case, is supported between the guide yoke and the cross tie extending continuous across the frames just back of the first driver and supported by knees secured to the main frame. This cradle carries all of the weight of the gear proper. The pins throughout are hardened steel and run in hardened bushings.

One of the illustrations shows the valve ellipse given by this gear in comparison with the ellipse given by other radial gears, from which it can be seen how this combination of motions



COMPARISON OF VALVE ELIPSES.

works to correct inaccuracies of other designs of radial gears. The indicator cards, shown in another of the illustrations, illustrate these points even more clearly and give a comparison between the Walschaert and the Baker-Pilliod gears, from which the points of superiority of the latter, in the matter of steam distribution, are evident. These cards were taken from engines of the same class, make, and on the same railroad, working in similar service. The most noticeable features illustrated by these cards are the quick opening of the Baker-Pilliod gear, which gives a full port opening on 5 per cent. piston travel in full gear operation, and thus carries full steam pressure up to the point of cut-off; the delayed release which occurs at 90 per cent. of the stroke in comparison with 75 per cent. with the Walschaert, and gives a much longer expansion line; the free exhaust, due to the same cause as the full steam line, *i. e.*, quick movement of the valve at this point; the delayed compression and absence of pre-admission.

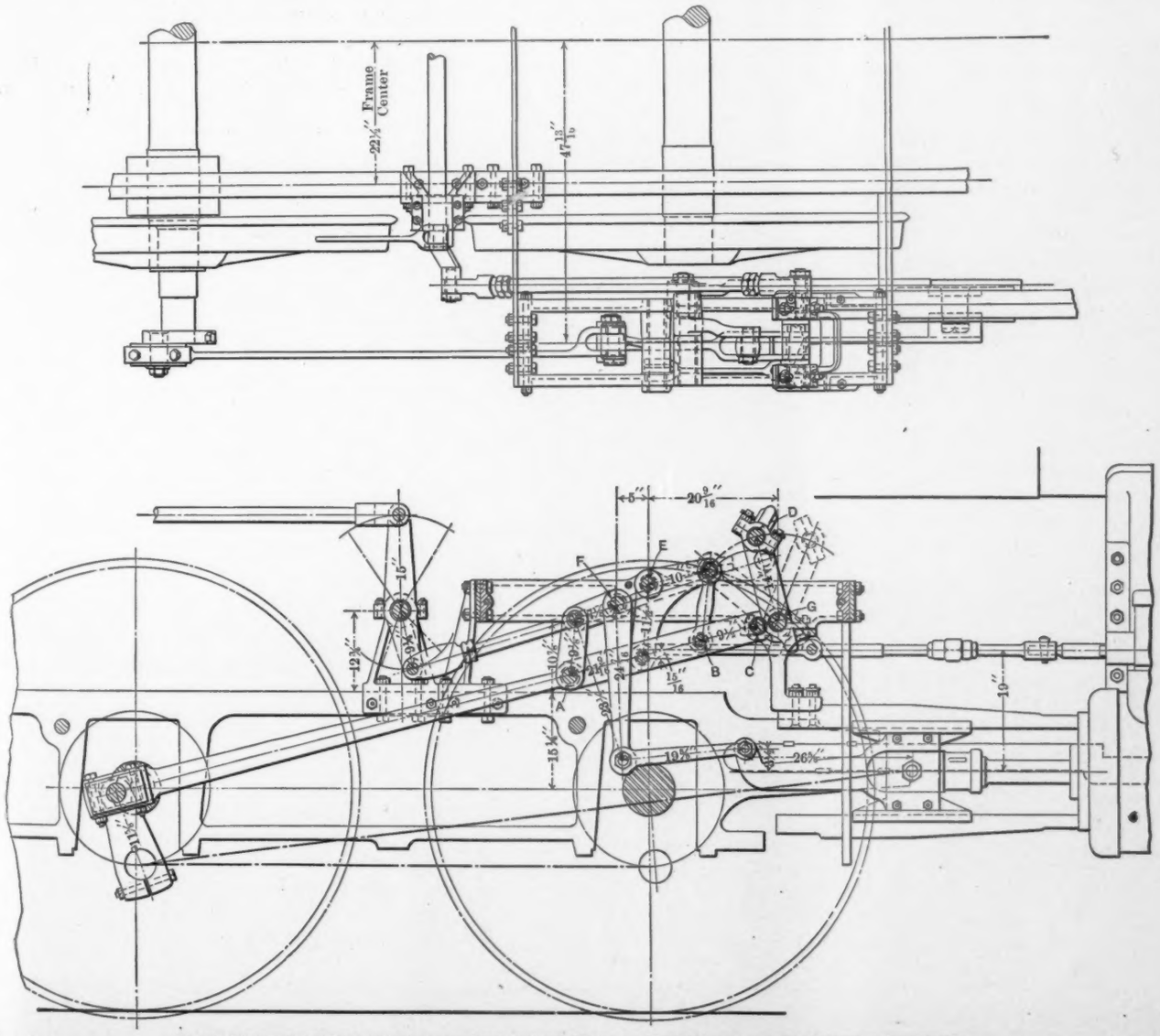
The gear gives a constant lead the same as the Walschaert and weighs 3,236 lbs. total, of which the moving parts on both sides of the engine give but 1,028 lbs. for the locomotive shown in the half-tone. This locomotive (No. 42, T. S. & L. & W. R. R.) was run opposite No. 40 for several months, and during the month of July the comparison of coal consumption is given in the following table:

TOLEDO, ST. LOUIS & WESTERN RAILROAD CO.

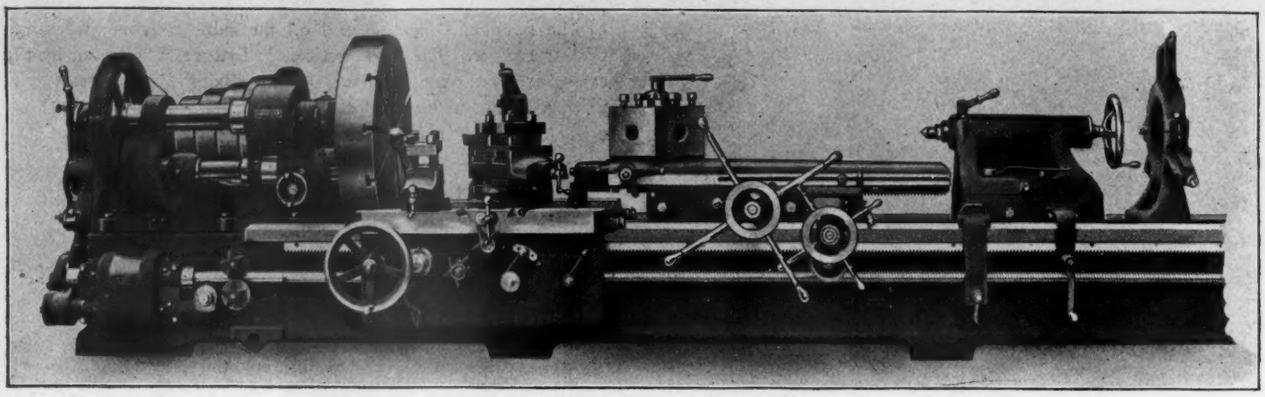
PERFORMANCE OF ENGINES 40 AND 42 FOR THE MONTH OF JULY, 1908.

	40	42
Miles traveled	4,914	5,587
Passenger car miles	17,286	23,154
Tons coal consumed	280	256.5
Average miles run per ton	17.5	21.7
Pounds of coal consumed per engine mile	114.4	91.8
Pounds of coal consumed per passenger car mile	32.3	22.1

Engine 40 equipped with Stephenson Link. Engine 42 equipped with Baker-Pilliod Valve Gear.



PLAN AND ELEVATION OF BAKER-PILLIOD VALVE GEAR AS APPLIED TO A TEN-WHEEL LOCOMOTIVE.



AMERICAN TRIPLE GEARED LATHE WITH TURRET ON THE SHEARS.

36-INCH TRIPLE GEARED AMERICAN LATHE WITH TURRET ON THE SHEARS.

The American Tool Works Company, Cincinnati, has recently built one of the thirty-six inch, heavy pattern, triple geared lathes with a turret on the shears, as shown in the illustration. The back gears are automatically disengaged when slipping the pinion into the internal gear. The longitudinal feed of the carriage is controlled by a friction, and the cross feed by a saw-tooth clutch, operated by the "star" handle on the apron. The rack pinion in the apron is withdrawn while thread cutting.

The feed box, on the front of the machine, below the head-stock, supplies three instantaneous changes for feeding and screw cutting for every change of gears in the quadrant at the head end of the lathe. The compound rest is fitted with a "four stud" tool holder, the tool resting on a serrated steel base. This rest may also be equipped with a double T slotted top-slide and with regular tool posts set in tandem, which prevents the cutting tool from slipping under heavy duty.

The turret is of new design and is equipped with an indexing mechanism which is self-compensating for wear. This mechanism is located at the front of turret top-slide, bringing the locking-pin very near to the tool. The turret may be tripped or revolved automatically, or by hand; the mechanism may be set so as to be inoperative, when it is desired to run the slide back to extreme limit, without withdrawing the locking-pin or revolving the turret. This is accomplished by the small lever shown near the large pilot wheel. The turret top-slide is supported on its outer end by a gibbed bracket attached to the front of the slide, which travels along the V's of the bed. This support eliminates all tendency to spring under a long reach. The bracket may be removed should the work require that the turret slide pass over the carriage of the lathe. The bottom-slide of the turret is moved along the bed by the pilot wheel shown at rear end. It is clamped to bed by two eccentrics, one at the front end and the other at the rear. It is further secured from slipping, due to severe end-thrusts, by a pawl, which, dropping from the turret, engages a rack cast in the center of the lathe bed.

The turret is supplied with eight carefully selected feeds, ranging from .005 in. to .162 in.; these are entirely independent of the regular carriage and apron feeds. The turret feeds are controlled by the two "star" knobs, carrying index dials, which are shown one directly above the other to the right of the feed box. The dials and pointers indicate at once the feed in inches, as set; all changes may be made while the lathe is running. The "star" knobs operate through shafts, extending through the bed to the quick-change turret feed-box at the rear of head-stock, which is provided with a neat and substantial cover.

Provision is made to quickly attach the turret top-slide to the compound rest slide. This is valuable when it is desired to impart the feeds of the carriage to the turret, such as in large tapping operations. In such cases the taps get a "positive lead," since the screw cutting mechanism may be engaged in the apron and the proper lead thereby transmitted to the turret slide, carrying the tap. This feature relieves the tap of all "dragging at the start" and the "positive lead" prevents the reaming tendency of the tap on the hole, at the start, which would spoil the work. This feature is also of value in ordinary jobs of chasing internal threads with a turret tool.

The turret feeds may be reversed, a valuable feature when it is necessary to "back face" or "counter-bore." Reversal of feeds is controlled by a lever, conveniently located on the driving sprocket of the quick-change turret feed-box.

The taper attachment is of heavy and substantial construction and is designed to eliminate all binding tendencies of the parts, thereby insuring smooth and uniform action. It is given a support on the bed and is supplied with a vernier attachment to facilitate fine adjustment. It is graduated and the entire attachment is bolted to and travels with the carriage. It may be quickly engaged or disengaged at will, without disturbing the taper, as set.

PORTABLE OXY-ACETYLENE WELDING AND CUTTING MACHINE.

ANDRÉ BELTZER.*

The large advantages which the oxy-acetylene process of welding and cutting offers to manufacturers, railroads and contractors are now pretty generally understood and it is not necessary for me to discuss them in a general way. So I will confine my discussion to a new portable equipment which makes it possible to take advantage of the wonderful possibilities of this new method much more generally than has previously been the case.

Practically all of the welding machines which have been installed in the United States are stationary, that is to say, it is necessary to bring near the machine the pieces which are to be welded or cut. In many cases (repair of a leak in a power plant, repair of a locomotive, etc.) this transportation is impossible, or it means a big cost of handling, and it is necessary to forego the advantages of the process. It is for this reason that the Beltzer-Delcampe Welding Co., Bridgeport, Conn., who are manufacturing welding machines of all sizes, have invented and are manufacturing a portable oxy-acetylene welding and cutting machine weighing not more than 750 lbs., which can be installed on a wagon four by eight feet.

A portable machine can be easily imagined in connecting a tank of oxygen and a tank of acetylene with a blowpipe, but everybody knows that the expense of the two gases compressed in tanks would render the process impracticable, especially for cutting work or repairing of big castings, where considerable quantities of gases are used.

The machines as manufactured by the Beltzer-Delcampe Welding Co. are, however, really small portable welding factories. The two gases, oxygen and acetylene, are liberated in special generators from a cheap powder called "oxyvite" and calcium carbide. The oxyvite has the property of liberating 100 per cent. pure oxygen at a low temperature and absolutely free of any gas

* Chemical Engineer, Bridgeport, Conn.

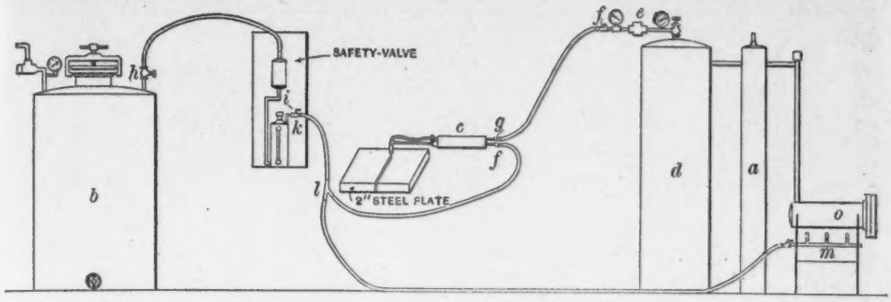


FIG. 2.—DIAGRAM OF CONNECTIONS OF A PORTABLE OXY-ACETYLENE WELDING OUTFIT.

which could corrode the metals and deteriorate the welding machine, as is ordinarily the case with oxygen liberated from chemicals. It is also entirely free of poisonous gases which would incommode the welders.

These machines offer special advantages to a railroad company in connection with the repairing of broken locomotive frames or cracked cylinders without taking them down and makes it possible to do this work in the engine house very conveniently.

A general view of this equipment is shown in Fig. 1 and a diagram of its connections in Fig. 2. The oxygen generator (a) produces, continuously, compressed oxygen gas in the most simple manner from oxyvite which liberates the gas without the slightest danger of explosion. The acetylene generator (b) is of most substantial construction, being specially made for rapid and rough handling. The blowpipe (c) with its set of nozzles, permits the welding of any thickness of sheets up to 1¼ inches, and repairing of castings of any dimensions. The same blowpipe by changing the nozzle, is used for the cutting of steel up to 4 inches thick.

The oxygen pressure tank (d) is fitted with a reducing valve (e), and the exit pipe of the tank connects with the oxygen pipe (g) of the blowpipe. The exit pipe (h) of the acetylene generator is connected with a safety-valve (i), the purpose of which is to prevent the forcing back of oxygen toward the acetylene generator, as for instance in case the exit nozzle of the blowpipe should be stopped by molten metal. The exit pipe (k) of the safety-valve is finally connected with the acetylene cock (f) of the blowpipe. There is a branch at (l) on the acetylene line connecting with acetylene bunsen burners which supply the heat required by the oxyvite retort (o). The acetylene generator is loaded with 12 lbs. of carbide, and the oxygen retort with a corresponding amount of oxyvite. In twenty minutes after the lighting of the burners the oxygen tank is filled with pure oxygen gas at 100 lbs. pressure, and the machine is ready for welding and cutting.

It may be interesting to consider the cutting process in detail, as this is not so well known or easily understood as the welding, and in many cases is the more important use of the equipment.

The principle of the process is very simple. The metal is heated to a red heat by means of the oxy-acetylene flame and a pure jet of oxygen, directed on the red spot, burns the iron to a mixture of the two oxides FeO and Fe_3O_4, which flows down, and leaves the narrow scarf. The great heat liberated by combustion of iron in pure oxygen makes the cutting very rapid. According to Dulong, a French chemist, one atom of oxygen 16 grammes liberates, on combining iron, 8,940 calories of heat. The carbon which evidently does not play any active part in the cutting, and is contained in steel only in small quantities, liberates only half of the heat which iron gives: 16 grammes oxygen liberates with carbon but 4,710 calories of heat.

The oxy-acetylene flame which accompanies the jet of oxygen has only a secondary function which is to start the process by heating the iron to the necessary temperature for its quick combustion in oxygen.

It seems very peculiar that all kinds of steel can be cut with this process and that cast-iron, whose main component is iron, is cut but very slowly. The reason of this is probably a physical one, i.e., cast-iron melts with the oxy-acetylene flame to a very thick liquid and the jet of oxygen seems to slide on this molten metal without penetrating it.

The following table gives the expense for gases in cutting steel plates of various thickness by the machine under discussion:

Thickness of Plate, Inches.	Time Required to Cut 1 Foot, Minutes.	Oxygen Required, Cu. Ft.	Acetylene Required, Cu. Ft.
¼	0.6	...	..
½	1.0	1.5	0.5
1½	3.8	10.	2.5
1¾	4.2	10.8	2.7
2	6.0	15.5	4.1
2¼	6.6	17.1	4.5

When the metal to be cut is first heated the expense is considerably reduced. For instance, a plate 1¾ inches thick, heated to such a temperature that it begins to become red, can be cut at a speed of 2 ft. per minute, which is eight times faster than for cold metal, and with the cheap oxygen supplied by this machine the cost of cutting a foot of 1¾-in. steel plate is but 3.3 cents.

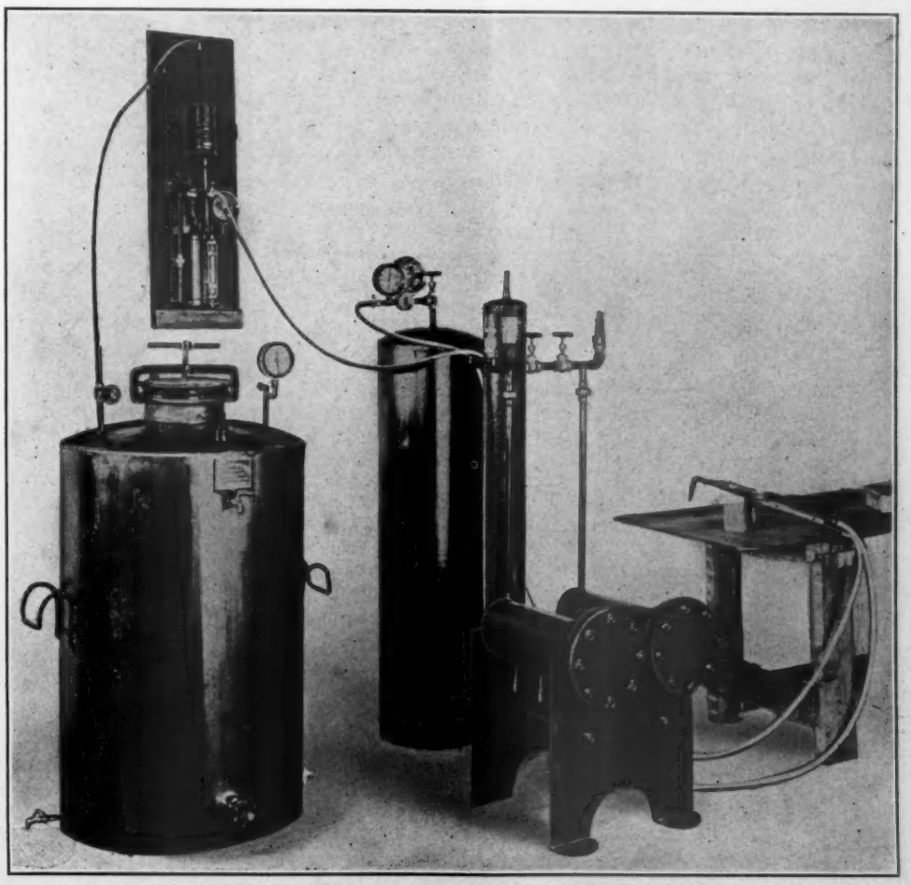
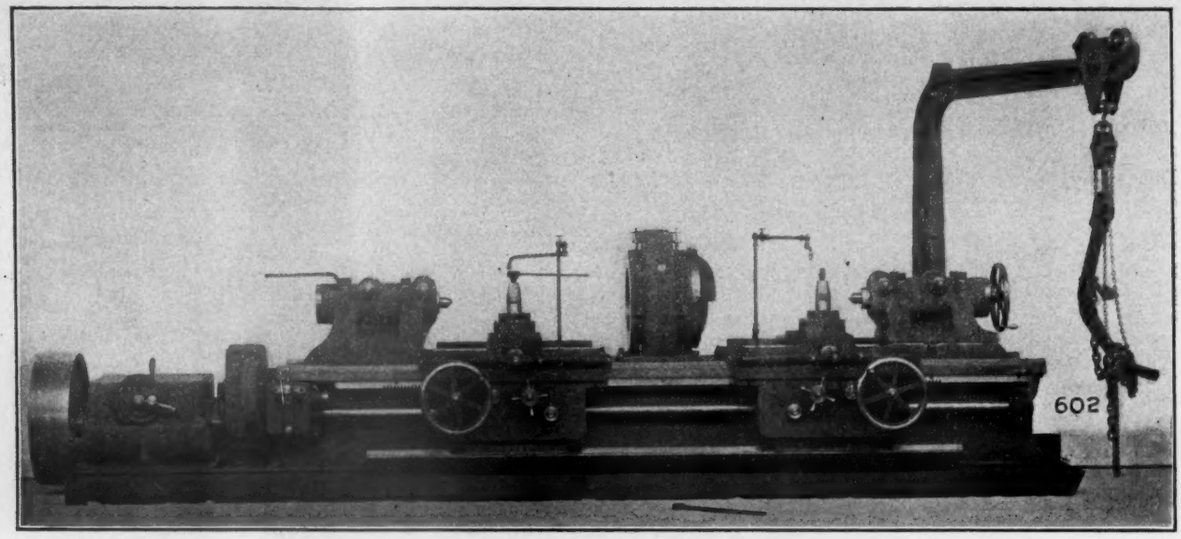


FIG. 1.—PORTABLE OXY-ACETYLENE WELDING OUTFIT.



LODGE & SHIPLEY HEAVY AXLE LATHE.

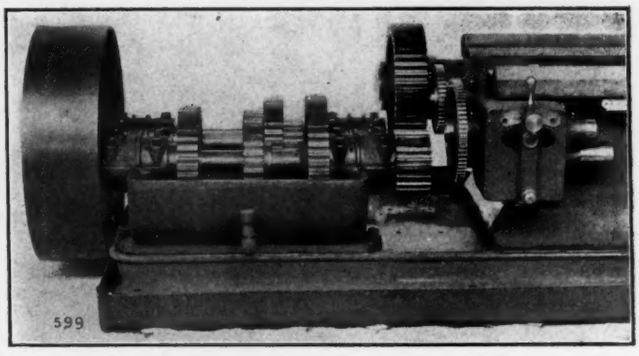
HEAVY PATTERN AXLE LATHE.

An extra heavy axle lathe, manufactured by The Lodge & Shipley Machine Tool Company of Cincinnati, is illustrated herewith. It is of rigid construction, has a powerful drive and is equipped with all the conveniences which are desirable for this class of work.

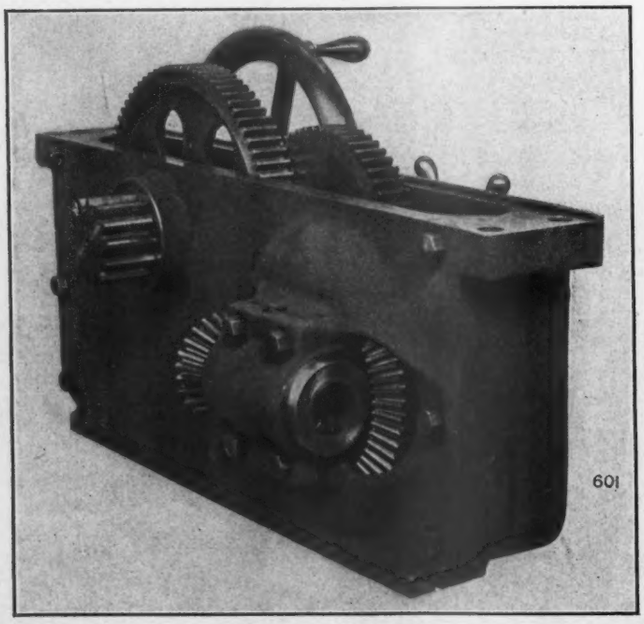
The bed is of massive construction, the cross girths being of box section. A longitudinal member, of box section, is cast in the center of the bed, extending its length, parallel to the outer walls, and is for the purpose of further stiffening the cross girths. The walls of the bed are heavy and the metal on the upper and lower edges is as nearly equal as possible. The ends of the bed are cut away to facilitate the removal of the tailstock, or permit of a reasonable overhang for unusual lengths of work. In addition to the front and rear V's, with the inner flat tracks, an additional 45 degree plain surface has been machined upon the bed to support the carriage apron at the bottom.

The drive is simple and powerful. Power is applied to a constant speed pulley of large diameter and wide face, running at a high velocity. The variation in speed is obtained by sliding gears, which run in a bath of oil. All shafts are carried in bushed, positive ring oiled bearings. All gearing is of steel. The driving shaft is of large diameter and is held in alignment by a number of journal blocks bolted to the bed. There is no overhang of the pinion of the main driving gear, the shaft being supported on either side of it in long bearings. The large gear, meshing with this pinion, is placed in the center of the drivng head, and like the pinion has a double bearing. A powerful compensating driver is secured to the gear in the head by dogs which are faced with steel plates.

All feed gears are of steel. The speed of the splined feed rod



DRIVING AND FEED GEARS.



DOUBLE, OR BOX APRON.

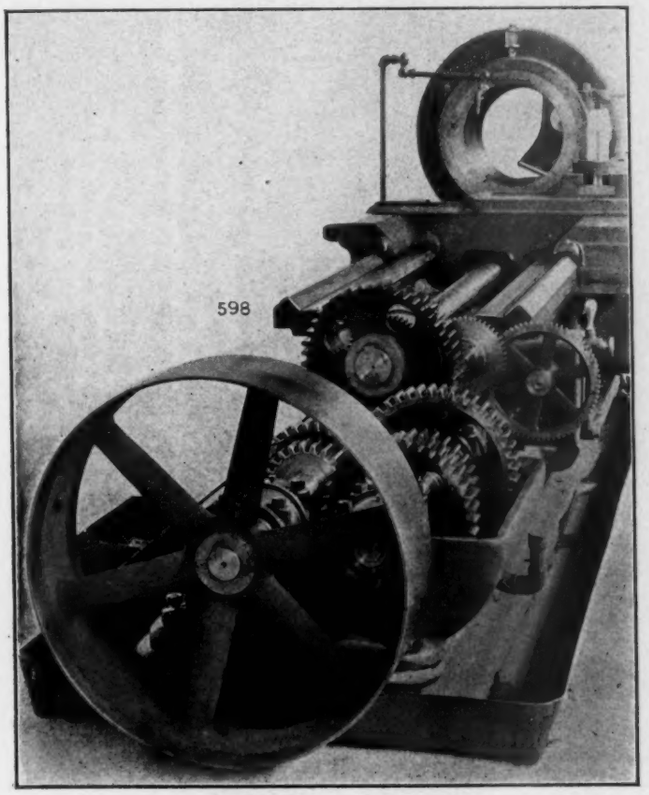
is governed by the gear train driving from the main shaft through a change gear box, giving three feeds which may be changed while the lathe is in operation.

The apron is of compact box construction, which is tongued and grooved into the carriage. In addition to the clamping arrangement of the apron to the carriage, the apron is further supported by a third V cast on the bed, and in such position as to be directly under the apron. The purpose of this is to support the apron at the bottom for both vertical and transverse stresses. The spring of the apron due to the thrust from the rack pinion is thus effectively overcome.

In addition to the bearing on the V's, on the front and rear shear of the bed, the carriage also has a flat bearing, or track, on the inside of the front shear. A further angular bearing of 45 degrees tends to secure a permanent alignment of the carriage with the bed. The carriage bearing upon the bed is of importance because of the great thrust from the burnisher, as well as from heavy cutting. Water troughs are provided around the tool slide and wings of the carriage. The tool posts are arranged with hardened toothed plates interlocking with the tool and effectively preventing any possibility of the tool swiveling, or slipping, under the heaviest cuts. The tool slide is of steel.

The tailstocks are of massive construction and firmly bolted to bed. A pawl, engaging with a rack, cast in the bed, is attached to each tailstock, this design tending to relieve the strain

on clamping bolts and overcome the thrust of heavy cutting, when blunt cutting tool angles are used. The tailstock, at the driving end, has a stationary spindle with no transverse adjustment, the necessary adjustment being obtained from the spindle of the second tailstock, which is provided with a transverse adjustment. The plug clamps for binding the tail spindles are of



END VIEW OF AXLE LATHE WITH GEAR CASE REMOVED.

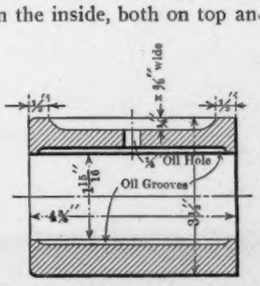
improved design; there are two instead of one for each tailstock, and they are placed at the top of the spindle barrel.

Provision is made for delivering an adequate supply of water to the tools; all journals are copiously supplied with oil by means of positive automatic oil rings.

22-INCH CINCINNATI PLANER.

Until recently The Cincinnati Planer Company, Cincinnati, Ohio, has not built planers smaller than 24 inch. A short time ago, however, it added to its line a machine which planes 22 in. wide, 22 in. high and 5 feet in length, with two cutting speeds, 24 and 50 ft. per min.

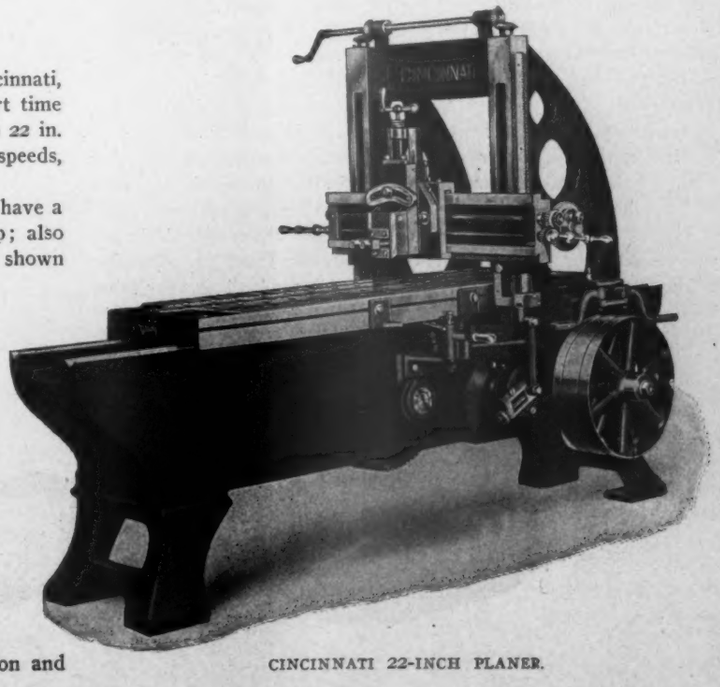
The bed is bored for shaft bushings and these bushings have a groove milled on the outside about 3/8 in. wide and deep; also an oil groove cut on the inside, both on top and bottom, as shown



in the sketch. This method insures positive lubrication and prevents the scoring of the shafts. The bed is fitted with oil rollers for automatically oiling the ways.

The shifting device is of a new and simple construction and is designed with special reference to high speed and short stroke work. It is provided with a safety locking device and with a handle on the rear side of the bed so that the machine may be operated from either side. The crank handles on the rail are fixed in their places and the handle itself is fitted loose so that the operator can retain a tight hold on it while turning the screw or rod rapidly.

The saddle is graduated to 360°, or a full circle, so that the angles may be read from both sides of the machine. The down feed screw is fitted with a collar graduated to thousandths. The gearing is very powerful and cut from solid stock; the large gears and rack are made from semi-steel castings, and the pinions from steel forgings. While all of the parts of the machine have been made very rigid for heavy service, special attention has been given to facilities for rapid handling.



CINCINNATI 22-INCH PLANER.

STOPPING BLOCK FOR ENGINES IN ROUNDHOUSE.

There is a point which I wish some one might bring out, and that is a means of preventing locomotives from passing through the outer walls of the house occasionally. In the modern houses we have large air ducts under the floor around the outer walls of the house, and if this thing, which has happened so frequently in the past, continues to happen, the results will be somewhat serious to the structure and, incidentally, to the record of the output of the locomotives from the roundhouse for the time being.

We experimented with a cast iron chock to prevent the engine from going too far, using one that would allow the pilot to pass over it, bolting it securely to the rails. By repeated trials it was quite conclusively shown that any chock that would allow the pilot to pass over it would not be sufficient to stop an engine if it got beyond control even to a moderate extent only. From the result of these experiments a chock was made and used in one house, and will be used in at least one other, which stands up about ten inches above the rail, fitting the shape of the ordinary wheel which will strike it, but, of course, before the wheel gets to it the pilot will be broken or, in case the engine backs against it, some of the brake gear may suffer. We concluded that it was better to run the chance of some slight damage of that kind than the more serious damage that would result from breaking into the air duct and through the wall, at the same time probably causing serious injury to the locomotive.—*William Parker before the New England Railroad Club.*

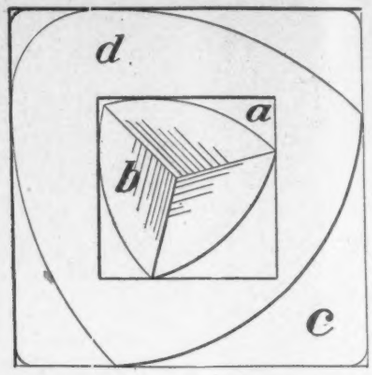
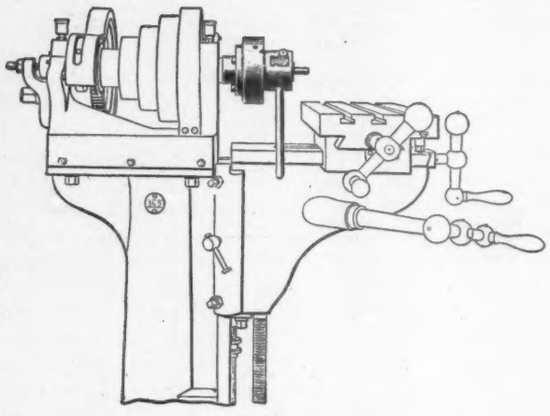


DIAGRAM ILLUSTRATING THE WORKING OF THE DEVICE.



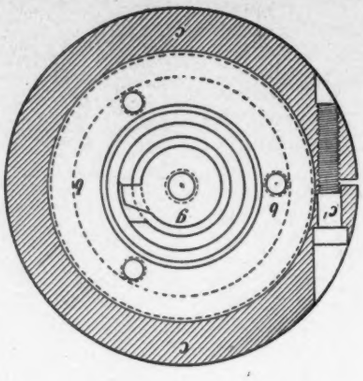
APPLICATION OF CHUCK TO MILLING MACHINE.

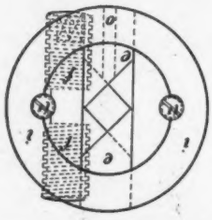
BORING SQUARE HOLES.

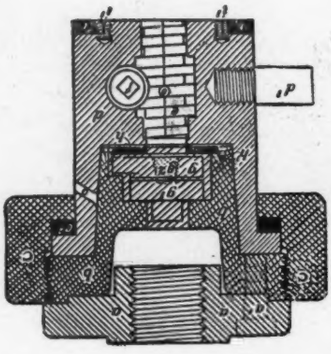
An attachment, or chuck, which may be used on a lathe, milling machine, or drill press, for boring square or angular holes in metal, has been used with success in Germany during the past two years.

The chuck, which is shown in the illustrations, consists essentially of three parts; first, a driving part, which is screwed to the spindle of the machine; second, a stationary part, which may either ride upon the first part by means of a bearing, or be fastened directly to the frame of the machine; and third, a part into which the shank of the drill is screwed and which is caused to rotate by the first part, but is also free to move sidewise to a certain extent. This sidewise motion is limited by a guide or matrix in the second or stationary part, the exact amount and form of the motion being determined by the shape of the guide and by the shape of the shank of the tool.

The tool for boring square holes has a three-cornered shank, the sides being segments of circles struck from the opposite angles or edges as centers, and the radius of all three circles being the same or equal to one side of the square guide in which the shank turns. By reference to the diagram, it will be seen that when one side of the shank is either rolling or sliding upon one side of the square guide, the opposite edge of the shank will move in a straight line. This holds true for all positions of the shank except for a very small distance at the corners. If it is desired to bore a square hole with sharp corners a special tool is employed having a shank considerably larger than the cutting head, one of the corners of the shank being rounded instead of angular. The exact form of this shank has been worked out empirically and standards have been made for all the sizes of holes likely to be needed in practical work.



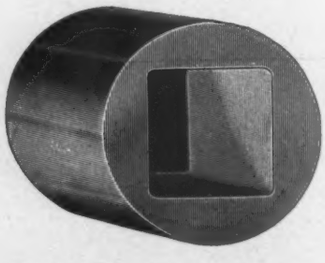




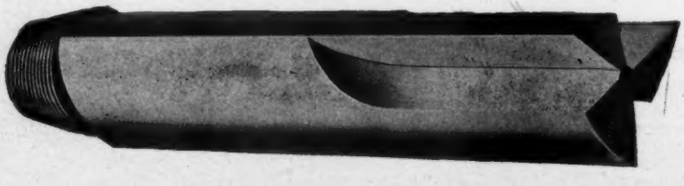
DETAILS OF CHUCK FOR BORING ANGULAR HOLES.

The cutting edges of the tool are on the end, as in the case of either flat or twist drills. To do commercial work with this device, it is necessary to have as many different drills as there are sizes of holes to be bored, but the matrix or guide in the stationary part of the chuck can be adjusted to a considerable range of sizes, making only one chuck necessary. Where it is desired to bore triangular, pentagonal, or hexagonal holes, or other forms of holes, a corresponding tool and matrix may be supplied.

For grinding the drills a special attachment is used, which may be applied to any grinder.



AN EXAMPLE OF THE WORK DONE.



AN ANGULAR DRILL FOR DRILLING SQUARE HOLES.

The Radical Angular Drill & Tool Company control the patents for this country, and are demonstrating the working of these drills at 114 Liberty street, New York, with a view to introducing and manufacturing the device in this country.

THE ABUSE OF THE MASTER CAR BUILDERS' ASSOCIATION REPAIR CARD.*

J. J. HENNESSEY.

If, as required by the Master Car Builders' rules, the road which did the incorrect work applied a M. C. B. repair card covering the items objected to, its identity would of course be immediately known, and the adjustment of the account would be a very easy matter. The application of the repair card in all cases of repairs to foreign car equipment as required by the M. C. B. rules, is not, I am very sorry to state, being done, and the fact that these repair cards are not being applied, brings to us a very difficult problem for solution. The road with which I am connected has cases coming up every day where our cars are offered home to us with wrong repairs to sills, trucks, draft gear, and other very expensive parts of our equipment, and the expense of correcting these is enormous, and we cannot afford to bear it. The repair card is invariably missing, and we are then forced to the only method of ascertaining by whom the repairs were made, and this leads us to that same old story of tracing with its attendant voluminous correspondence, loss of time, and expense, to say nothing of the burden placed upon the office forces of our motive power and car accounting departments. This difficulty has been growing worse from year to year, until now it presents a very serious condition with no apparent relief in sight. It is to be deplored that this particular rule is so flagrantly violated.

In the regular course of business our cars drift hundreds of miles from home and we have to depend upon the honesty of the foreign lines in the matter of repairs and the rendition of bills. There are instances without number where foreign roads have noted upon their repair cards that wheels were renewed account of sliding, axles renewed account cut journals, air hose renewed account missing, and numerous other parts repaired or renewed, for which the possessing road assumes the expense of such repairs because of the manner in which the defects were brought about. If the foreign lines were dishonest they could have reported such defects as the result of ordinary wear and tear and rendered bills for the work. It would not, therefore, be consistent for us to assign dishonesty as the cause of non-application of the repair card when repairs are made to foreign cars.

My personal opinion is that it is due to indifference on the part of our repair men. I have heard it said that the application of the repair card is not really necessary in view of the fact that the stub of such card reaches the car owner with the repair bill, or when sent through the mails in case no bill is rendered. This we all know is a grave mistake, as it is necessary to know immediately, when the car reaches home, where the incorrect repairs were made in order to avoid the objectionable tracing. It has also been stated that insufficient time is given to execute and apply repair cards when making up trains or when trains stop for only a brief period at repair points. I have looked into this and found that by having repair cards dated and signed, that it requires only a trifle more additional time to fill in the other necessary data and apply the card, as it means only minor repairs such as air hose, journal bearings, brake shoes and the like. I am therefore satisfied that this objection can be overcome if only an effort is made.

The road with which I am engaged has what we term a traveling inspector, who is continually traveling over our system. It has been made part of his duties to look over foreign cars taken off our various repair tracks; also such foreign cars as receive minor repairs in the yards. If he finds any repairs made to such cars and no repair card attached covering the items, he reports it to headquarters and also to the foreman in charge at the local point, and the party at fault is easily located and disciplined. Headquarters also censure the foreman for allowing such violation, so that there is considerable incentive for the foremen to be vigilant in this regard. We have found this to be productive of very good results, and we have also found that the mere issuance of an order to apply repair cards in all cases of foreign car repairs, does not bring about the desired result; there must be something done to show that you mean to have the order obeyed.

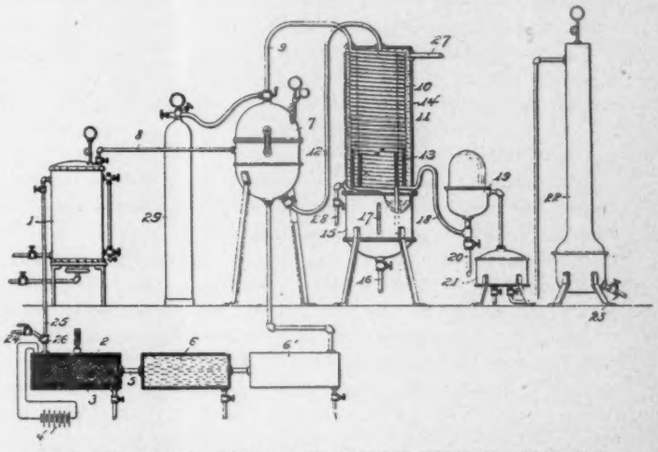
* Extracts from a paper read before the December meeting of the Western Railway Club.

DENATURED ALCOHOL FROM NATURAL GAS.

The production of denatured alcohol from natural gas can be made at a cost which permits it to compete successfully with gasoline or other petroleum products for light, heat or power. The apparatus for this distillation is shown in the accompanying illustration, being patented by the Continental Natural Gas Alcohol Company of Wheeling, West Virginia.

The percentage of methane contained in natural gas varies with the locality, but on an average it is about 94 per cent. The percentage of alcohol which may be produced from the gas varies with the percentage of methane. The processes consist of subjecting the natural gas to an electrically heated German silver, closely woven, fine wire gauze coiled and enclosed in an enamel retort. By subjecting the gas to heat and combining it with oxygen in the presence of steam, which prevents complete combustion and maintains the temperature below the decomposition point of alcohol; destructive distillation or oxidation of the gas is induced, resulting in the latter being converted into a fluid containing alcohol, benzol, nitric acid and prussic acid in varying proportions.

Referring to the illustration, the German silver gauze, electrically heated, is contained in retort No. 2, from which distillate



APPARATUS FOR DISTILLATION OF ALCOHOL FROM NATURAL GAS.

goes to retort No. 6, where it is partially cooled and condensed and by specific gravity the products of condensation are partially separated. These are then passed directly to an airometer 7. From the airometer the volatile products are passed under pressure, through a pipe 9 to the outer coil 10 of a water cooled distillator 11, while the condensed or liquid portion of the product is passed in the form of alcohol and dehydrogenated alcohol, through a pipe 12 to the inner coil 13 of the distillator, thence directly conveyed into a manometer 15, and then drawn off through an outlet tube or faucet 16, a specific gravity meter 17 being employed, whereby the separation of the liquid into its various constituents is facilitated. For further refining, the product of distillation, which has passed to the overflow vessel 19 of a vacuum type with an outlet tube 20 may be conducted through a filter 21, and thence through a hydrometer 22 connected with pipe and faucet 23. 24 and 25 respectively indicate the gas and steam pipes, which are connected or united at 26 for directing the gas and steam together into the retort 2. The connections shown illustrate but one of various methods which may be employed.

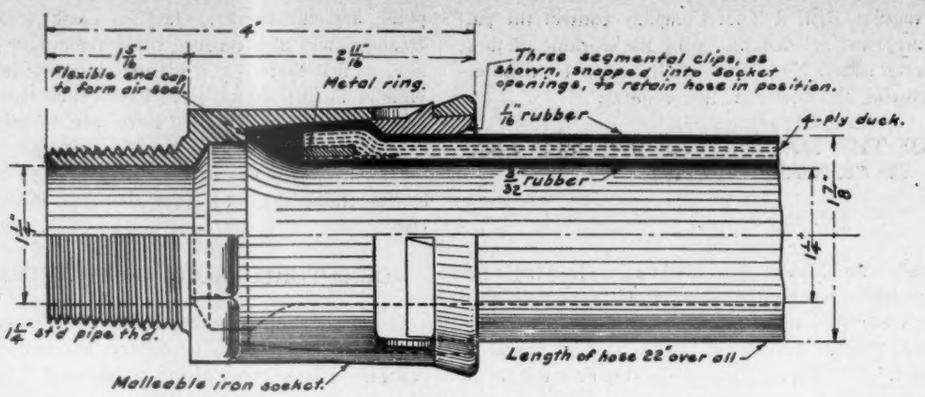


FIG. I.—METHOD OF ATTACHING "NB" CONNECTION TO AIR BRAKE HOSE.

"NB" AIR BRAKE AND SIGNAL HOSE CONNECTION.

The George M. Newhall Engineering Co., Ltd., of Philadelphia, Pa., are putting on the market a device designated as the "NB" air brake and signal hose connection. This was designed by E. D. Nelson, engineer of tests, Pennsylvania Railroad, and W. L. Brown, his assistant.

The objects sought in designing this coupling were to overcome injury to the soft inner tube of the hose by the nipples used in the ordinary form of mounting and to secure a method of fastening the hose to the metal parts which would be free from the danger of a hose pulling off the fitting.

The "NB" coupling is so designed as to avoid any contact of the metal parts with the soft rubber lining of the hose, and, therefore, preserves it against injury, thus leaving it free to perform its function of sealing the hose structure against small leaks, which eventually may cause bursting. (When the hose is inserted in the coupling the clip, as shown in the illustration, is driven against the shoulder of the hose until the lug on the clip springs into place through the aperture in the coupling. The hose is thus securely mounted without having anything in contact with the inner tube.)

Every railroad man, who has made a study of hose failures, knows that while the strength of the hose depends primarily upon the ability of the duck wrapping or jacket to hold the pressure, the safety of the hose against bursting depends absolutely on the integrity of the inner tube. A defect in the rubber lining permits air to find its way between and into the layers of duck, breaking through one or two of the inner layers and leaving only the outer layers to sustain the inner pressure. The pressure then, having only the remaining layers left, causes a rupture, and the result is a burst hose. The effect in freight service may be disastrous, due to the emergency application of the brake.

The internal nipples now generally used are responsible for a large percentage of such failures, because the constant swinging of the hose is resisted by the end of the nipple against the soft rubber tube, cutting into it and permitting the air to escape through and into the duck wrappings.

Carefully kept records show that about 60 per cent. of the hose failures in freight service are due to the bursting of hose at the nipples, and in passenger service the percentage is still higher. As will be seen from the cut, the use of "NB" couplings absolutely eliminates failures from this source.

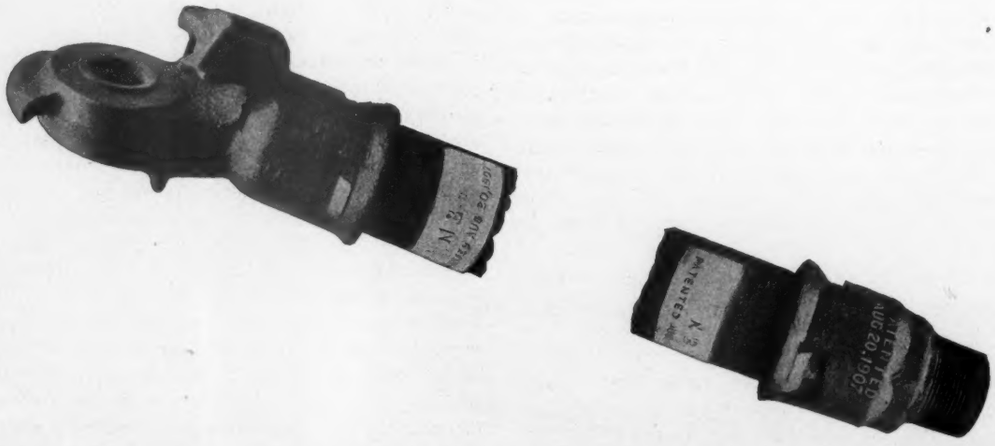
Hose mounted with the present standard fittings and with this improved form of fitting have been pulled apart in the same way as occurs in service when cars are separated, but the air brake coupling not uncoupled by hand. The result of repeating this a very large number of times showed marked cutting of the nipple in the inner tube with the standard fitting, and no injury whatever to the inner tube with the improved form of fitting.

As to security against pulling off, repeated trials have demonstrated that when mounted with the "NB" coupling the body of the hose has torn apart in every case, leaving the end of the hose still attached to the fitting.

The form of air brake and signal couplings and threaded nipples is the same as that in common use, so that there is no change in standard so far as the couplings and car fittings are concerned. "NB" hose and couplings can be mounted as quickly and as easily as the present M. C. B. standard.

This new coupling has the decided advantage of being practically indestructible. All the parts can be used over and over again, whereas with the present system it is always necessary to have new bolts and nuts, and in most cases new bands for every mounting.

Arrangements have been made with several of the largest hose manufacturers to make this special end on the M. C. B. or individual railroad specifications hose. It can also be obtained from the manufacturers of the coupling if desired.

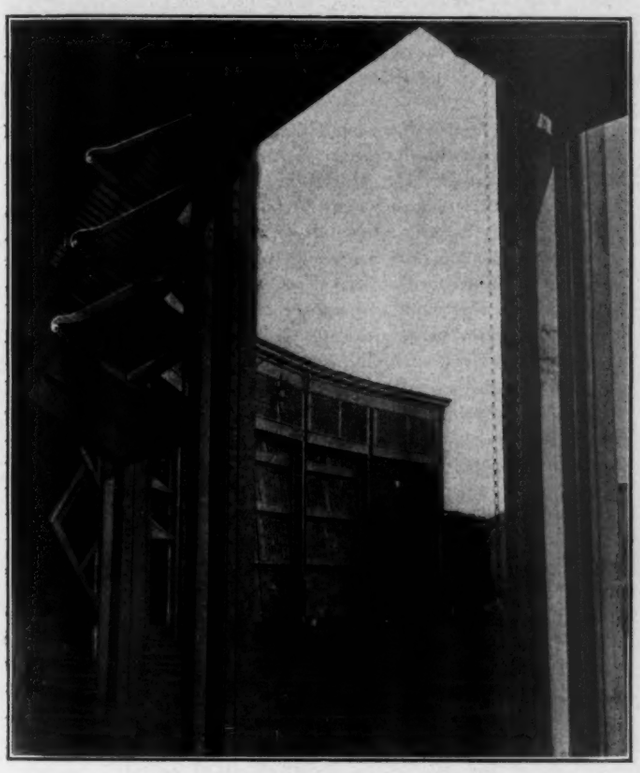


"NB" AIR BRAKE AND SIGNAL HOSE CONNECTION.

FOLDING DOORS FOR ROUNDHOUSES.

The accompanying illustration shows a roundhouse on the Cincinnati, New Orleans and Texas Pacific Railroad at Ferguson, Ky., in which there are twenty-one Ritter folding doors in use. This type of door has proven to be very successful for use at freight and store houses and would seem to be even better adapted for roundhouses.

One great advantage is, of course, that it occupies no ground



space when open and requires very little clearance up to a point as high as the top of a tank. Again, it cannot blow closed like a swinging door; it allows a maximum of clearance between cab and post, equalling a rolling door in this respect; it closes tightly and keeps the house warm; is easily operated by one man and thus will be kept closed in cold weather, and finally it permits a maximum of lighting area. All of these points are of great importance in a roundhouse in cold climates.

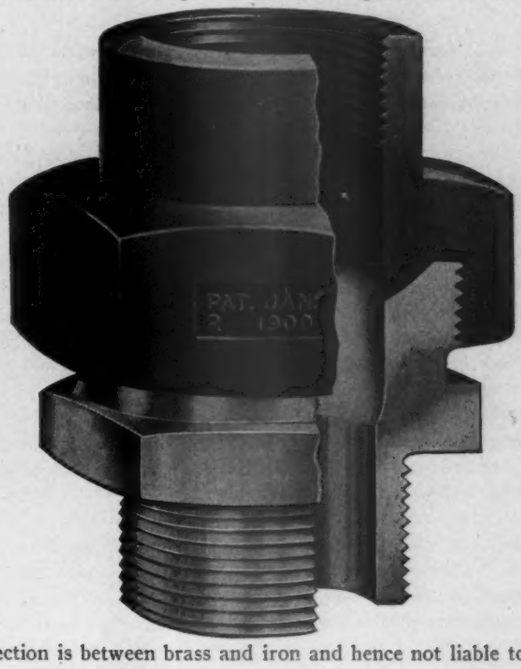
The construction is evident from the illustration. The operation is by an endless chain over a chain wheel at the top, which is direct connected to a drum operating the chains attached to both sides of the door at the bottom and carrying counterbalances at the other end.

Doors of this type are also in use in roundhouses on the Cincinnati, New Orleans & Texas Pacific Railway and the Cincinnati, Hamilton & Dayton Railway and have been specified for some other roads. It has also been used in machine shops on quite a number of roads with entire satisfaction.

This design of door, in either steel or wood, is manufactured by the Ritter Folding Door Co., Cincinnati, O.

KEWANEE AIR PUMP UNION.

The National Tube Company, 1608 Frick Building, Pittsburgh, Pa., has recently brought out a new union for use in connection with locomotive air pumps. This design has a number of advantages over the type in ordinary use, principally due to the fact that it does not require the use of a gasket and the thread



connection is between brass and iron and hence not liable to corrosion. It has a ball seat arranged as shown in the illustration, which forms a tight joint without packing. These unions are thoroughly tested under 100 lb. pressure of compressed air before being put on the market and are guaranteed to be absolutely tight.

PERSONALS.

Manual Parra has been appointed master mechanic of the Mexican Ry. at Apizaco, Tlax, Mex., to succeed J. B. Cozart.

J. B. Cozart, master mechanic of the Mexican Railway at Apizaco, Puebla, Mex., has resigned to go to the Pan-American Ry.

W. A. George has been appointed superintendent of shops of the Atchison, Topeka & Santa Fe Ry., with office at Albuquerque, N. Mex.

Edward C. Cole has been appointed traveling engineer of the Iowa Central R. R., with office at Des Moines, Iowa, succeeding W. B. Ferris.

F. H. Reagan has been appointed assistant superintendent of shops of the Lake Shore & Michigan Southern Ry. at Collinwood.

Clarence Lessels has been appointed mechanical engineer of the Guayaquil y Quito R. R. of Ecuador, S. A., with office at Guayaquil.

J. K. Witman has been appointed superintendent of materials and supplies of the Philadelphia and Reading Ry., vice John H. Rankin, deceased.

Calvin Schreck has been appointed head foreman of engines of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Bellefontaine, Ohio.

A. West has been appointed master mechanic of District 1 of the Canadian Pacific Ry., with office at Kenora, Ont., succeeding A. H. Eager.

B. H. Lent has been reappointed road foreman of engines of the Arizona division of the Atchison, Topeka & Santa Fe Ry., with office at Needles, Cal.

B. F. Kuhn has been appointed general foreman of the Collinwood shops of the Lake Shore & Michigan Southern Ry. vice F. H. Reagan, promoted.

T. N. Ely, chief of motive power of the Pennsylvania R. R., has been granted a protracted leave of absence to visit Italy, France and Egypt. He sailed December 12.

George K. Anderson has been appointed road foreman of engines of the Albuquerque division of the Atchison, Topeka & Santa Fe Ry., with office at Winslow, N. Mex.

W. L. Hudson has been appointed road foreman of engines of the Pittsburgh division of the Pennsylvania R. R., succeeding J. K. Russell, retired, with headquarters at Pittsburgh.

The offices of M. S. Monroe, master mechanic, and J. P. Callahan, master car builder, of the Chicago, Lake Shore & Eastern Ry., have been moved from South Chicago, Ill., to Gary, Ind.

E. J. Shoffner, foreman of the frog and rail mill of the Norfolk & Western Ry. at the Roanoke shops, has been appointed general foreman at Cleveland, Ohio, succeeding H. F. Staley.

Daniel Royce, formerly assistant editor-in-chief of the *Railway Age*, has been appointed assistant to W. V. S. Thorne, director of purchases of the Harriman Lines, with office in New York City.

A. W. Horsey has been appointed master mechanic of the Chalk River section of District 4 of the Canadian Pacific Ry., with headquarters at Smith's Falls, Ont., succeeding G. T. Fulton.

W. H. Thorn has been appointed general storekeeper of the Chicago, St. Paul, Minneapolis & Omaha Ry., with headquarters at the St. Paul, Minn., shops, succeeding G. A. Gipple, assigned to other duties.

W. J. Spearman has been appointed general foreman of the Missouri Pacific and St. Louis, Iron Mountain & Southern Rys., with office at Kansas City, Mo., succeeding A. Hewitt, assigned to other duties.

W. D. Knott has been appointed purchasing agent of the Atlanta, Birmingham & Atlantic Ry., with office at Atlanta, Ga. The duties of purchasing agent have previously been performed by Alex Bonnyman, general manager.

Frederick Regan, formerly with the Chicago & Alton R. R. in the motive power department, has been appointed master mechanic of the southern division of the Kansas City Southern Ry., with headquarters at Shreveport, La.

H. F. Staley, general foreman of the Norfolk & Western Ry. at Bluefield, W. Va., has been appointed master mechanic of the Carolina, Clinchfield & Ohio Ry., with office at Johnson City, Tenn., succeeding H. L. Hobbs, transferred.

P. C. Staley, foreman of the Mifflin shops of the Pennsylvania R. R., has been transferred to the Altoona car shops. E. H. Newbury, assistant engine house foreman at Derry, Pa., succeeds Mr. Staley. G. C. Schneider, inspector at Renova shops, succeeds Mr. Newbury.

T. P. Dunham, foreman of the Holidaysburg shops of the Pennsylvania R. R., has been transferred to roundhouse No. 3 at Altoona. P. C. Kapp, foreman of the State Line shops, succeeds Mr. Durham. C. D. Barrett, inspector on the New Jersey division, succeeds Mr. Kapp.

J. T. Robinson, master mechanic of the Seaboard Air Line at Savannah, Ga., has been appointed master mechanic at Jacksonville, Fla., succeeding H. P. Latta. He will have charge of all mechanical matters on the Seaboard Air Line in Florida. J. W. Sasses, general foreman of shops at Raleigh, N. C., succeeds Mr. Robinson.

John Reed, of the mechanical department of the Oregon Short Line at Salt Lake City, Utah, has been appointed general superintendent of the Salt Lake & Ogden Ry. at Salt Lake City, in place of A. D. Pierrson, resigned. Mr. Reed is succeeded by George Wilson, chief clerk of the master mechanic at Pocatello, Idaho.

J. E. Hickey, master mechanic of the International Ry. of Mexico, has been appointed superintendent of shops of the Mexican Central R. R., at Aguascalientes, Aguas., Mex., succeeding G. F. Tilton, assigned to other duties.

Joseph Bryan, owner of the Richmond (Va.) *Times Dispatch*, died at his home just outside the city of Richmond, on Friday, November 20th, after an illness of only a few days. Mr. Bryan was president of the Richmond Locomotive & Machine Works from 1898 to 1901, when the company was purchased by the American Locomotive Company, and at the time of his death was a director of the American Locomotive Company and managing director of the Richmond plant.

J. D. Harris has been appointed general superintendent of motive power of the Baltimore & Ohio R. R., succeeding J. E. Muhlfeld, resigned. Mr. Harris began railway work as a machinist apprentice on the Pennsylvania Lines West in October, 1889. He later became a locomotive fireman, and in March, 1895, was made assistant foreman and later foreman of the machine shops of the Pittsburgh, Fort Wayne & Chicago Ry. In February, 1897, he was made assistant road foreman of engines, and five months later became assistant engineer of motive power of the Northwest System of the Pennsylvania Lines West. In January, 1898, he was made master mechanic of the Eastern and Toledo divisions, with headquarters at Crestline, Ohio, and the next year was made master mechanic of the Cleveland & Pittsburgh, now part of the Pennsylvania Lines West. In 1901 he was made assistant to the general superintendent of motive power of the Baltimore & Ohio R. R., which position he held for two years, and then became assistant chief engineer and works manager of the Westinghouse Co., holding this position until his recent appointment.

Richard H. Soule, for thirty years active in railway work, died at his home, Brookline, Mass., December 13. He was born in 1849 at Boston, Mass., and began railway work in 1875 as draftsman in the mechanical engineer's office of the Pennsylvania Railroad, at Altoona, Pa. Two years later he became assistant in the test department. In 1879 he was made superintendent of motive power of the Northern Central. In 1881 he became superintendent of motive power of the Philadelphia & Erie division of the Pennsylvania, and a year later was made superintendent of motive power of the Pittsburgh, Cincinnati & St. Louis, now part of the Pennsylvania Lines West. In 1885 he was made superintendent of motive power of the New York, West Shore & Buffalo, now part of the New York Central & Hudson River, and later in the same year became superintendent of motive power of the New York, Lake Erie & Western, now the Erie, and two years later was made general manager. In 1888, leaving railway work, he became general agent for the Union Switch & Signal Co., but returned to the railways in 1891 as superintendent of motive power of the Norfolk & Western. From 1897 to 1899 he was with the Baldwin Locomotive Works, traveling for one year in South Africa and Russia, and for a year and a half was Western representative at Chicago. In 1900 he opened offices in New York as consulting engineer, retiring in 1905. Mr. Soule's series of articles on the arrangement and design of railway shops, which appeared in THE AMERICAN ENGINEER AND RAILROAD JOURNAL during 1903 and 1904, are regarded as classics on that subject. He was very active in the work of the Master Mechanics' and Master Car Builders' Associations.

George W. West, superintendent of motive power of the New York, Ontario & Western Railway, died on the evening of December 24, 1908, at his home in Middletown, N. Y. He had been in poor health for some time, suffering from kidney trouble and a weakened heart. Mr. West was born April 3, 1847, at Troy, N. Y., and hence was over 61 years of age. He has long been one of the best known and foremost motive power men of the country and has done his full share in advancing the science and practice of rolling stock design and maintenance. For many years he has been one of the most valuable members of the Master Mechanics' and Master Car Builders' Associations and has

prepared some of the most important reports and discussions that have been presented. He was president of the Master Mechanics' Association in 1902 and 1903. He has also been very active in the New York Railroad Club, of which he was a member for nearly 20 years. He was elected a member of the executive committee in 1892 and for the past seven years has been its chairman, having been re-elected at the last annual meeting. He was president of this club in 1894. He was also a member of the executive committee of the Central Railway Club and was president of that organization in 1901 and 1903. His character and manners were such as to compel admiration and to win him a very large circle of most loyal friends.

Mr. West was educated in the public schools at Troy and entered railway service as a machinist on the New York Central & Hudson River R. R. at Schenectady, in 1865. In 1867 he was transferred as foreman at Syracuse where he remained until 1873. For the following ten years he was master mechanic of the Chenango Valley R. R. and on its absorption by the West Shore Railroad was appointed general foreman at East Buffalo and the following year was appointed master mechanic of the Buffalo Division, where he remained until 1886. He was then appointed master mechanic of the Mahoning division of the New York, Lake Erie & Western R. R., with which he remained as master mechanic at different points until 1890, when he was appointed superintendent of motive power of the New York, Ontario & Western Railway, which position he has since held.

BOOKS.

Earth Slopes, Retaining Walls and Dams. By Chas. Prelini. 6 x 9. 129 pages. Cloth. Published by D. Van Nostrand Co., 23 Murray street, New York. Price, $2.00 net.

This book is largely given up to a consideration of the graphical methods of solving problems concerning the slopes of earth embankments, the lateral pressure of earth against a wall and the thickness of retaining walls and dams.

The Proper Distribution of Expense Burden. By A. Hamilton Church. 116 pages, cloth bound, 5 x 8 in. Published by *The Engineering Magazine*, 140 Nassau street, New York City. Price, $1.00.

Because railroad repair shops have not been in active competition, the matter of accounting has not been given the attention which its importance deserves. During the past few years, however, a distinct advance has been made in this respect, on several roads, thus making it possible to better direct the work of improving the shop efficiency. While Mr. Church's book describes principles which are applicable to manufacturing organizations, and especially to the machine shop, the broad principles may be studied and used to advantage in connection with railroad repair shop management. The contents by chapters follows: Interlocking general charges with piece costs, distributing expense to individual jobs, the scientific machine rate and the supplementary rate, classification and dissection of shop charges, mass production and the new machine rate, apportionment of office and selling expense.

Design of High-Way Bridges. By Milo S. Ketchum, C. E. 6 x 9. 531 pages. Cloth. Published by the Engineering News Publishing Company, 220 Broadway, New York. Price, $4.00.

The author of this work, in his position as Dean of the College of Engineering of the University of Colorado, was impressed by the comparatively slight attention that has been given to the design of high-way bridges by the many excellent books on bridge design. As a consequence many high-way bridges are very poorly designed, as is evidenced by the failures that have taken place in the past few years. A noticeable feature of this work is the attention given the subject of the sub-structure, a feature which is not always fully considered in works on bridges. A section of the book discusses the details of cost of different parts of high-way bridges, and should assist greatly in leading to economical design. The work is very completely illustrated and many sections are in the form of problems with the complete solution accompanying them.

Westinghouse Diary for 1909. Published by The Westinghouse Companies' Publishing Department, Pittsburg, Pa.

This is the fifth edition of this little vest pocket diary. Its 96 pages contain considerable new data. The section on "Electric Railway Data" devotes several pages to the single phase railway system. Nine pages are given to a consideration of the application of motors to machine tools. Following this are sections on electric heating; power transmission; meter testing; steam turbines, including high and low pressure turbines and the Leblanc condenser; gas engines; mechanical stokers; storage batteries, weights, measures and materials; Nernst, incandescent, tungsten and Cooper-Hewitt lamps; Union Switch and Signal Co. appliances; Morse chains, and gears. In addition to this technical information there are several maps, as well as considerable handy information; also a diary and pages for addresses and other memoranda.

Patents as a Factor in Manufacturing. By Edwin J. Prindle. 134 pages, cloth bound, 5 x 8 in. Published by *The Engineering Magazine*, 140 Nassau street, New York City. Price, $2.00.

The author's aim has been to lay down the fundamental principles concerning patents so that they may easily be grasped fully enough to direct the inventor, patentee or manufacturer in the early steps which are usually taken before the advice of counsel is secured. In the words of the preface the plan "is rather to convey an idea of the nature of a patent, the protection it may afford, the advantages it may possess for meeting certain commercial conditions, the safety which may be secured in relations between employers and employees, and the general rules by which the courts will proceed in upholding the patent and in thwarting attempted infringements, to show the manufacturer, in a general way, what may be accomplished by patents, but not to lead him to attempt such accomplishment without legal advice." Mr. Prindle is especially well fitted to discuss this subject and he not only brings out the information clearly but does it in a most interesting manner. The contents by chapters follow: Influence of Patents in Controlling a Market, Subject, Nature and Claim of a Patent, What Protection a Patent Affords, Of Infringemens, Patenting a New Product, Patent Relations of Employer and Employee, Contests Between Rival Claimants to an Invention.

Railroad Construction, Theory and Practice. By Walter Loring Webb, C. E. Fourth edition, revised and enlarged. 4½ x 6¾ in. 754 pages. Published by John Wiley & Sons, 43 E. 19th street, New York. Price, $5.00.

This standard work on the theory and practice of railroad construction, designed principally for use as a text book by students in colleges and technical schools, is too well known to require any extended comment. The fourth edition, now being issued, has been subject to some revision, especially in the chapter on "Earth Work," where several tables have been added. The chapter on "Economics" has also been revised to conform with more recent estimates of cost of operation. While this book is undoubtedly thoroughly modern and up to date in all of the features considered most essential by the author, yet to one acquainted with the progress in the motive power department of railways in recent years and its direct effect on roadway and economic problems, it seems peculiar that chapter fifteen, devoted to rolling stock, has evidently not been given any attention since the book was first prepared in 1899. While, of course, this chapter is not intended to be a course in the design of locomotives and cars, it would seem that it should, at least, give the modern practice in the features which it considers. For instance, it is odd to read that it is practically impossible to operate a consolidation type locomotive with all the drivers flanged and that such locomotives have only the front and rear drivers flanged. Again, in the second section, on the classified types, we find the "Columbia" type given, but do not discover the Pacific, Prairie, Santa Fe or any of the articulated types. The further statement that

37 square feet is about the maximum grate area obtainable except in a Wooten firebox, gives an indication of the date at which this chapter was written. We trust that the author in his next revision will bring this chapter up to the same standard as those on earth work, tunnels, ties, etc.

CATALOGS.

TECHNICAL BOOKS.—The Norman W. Henley Publishing Company, 132 Nassau street, New York, is issuing a new catalog of its varied assortment of practical technical books.

FRICTION CLUTCHES.—The Carlyle Johnson Machine Company, Hartford, Conn., has issued its 1909 catalog of the Johnson friction clutch. The different applications of the clutch are described and illustrated in detail.

RADIAL DRILLS.—The Fosdick Machine Tool Co., Cincinnati, O., is issuing a number of sheets, in a loose leaf binder, describing its 4, 5 and 6 ft., half and full universal radial drills.

TRANSFORMERS.—The Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., is issuing circular No. 1157, descriptive of type S distributing transformers for single phase power. The transformer is very completely illustrated and described in detail.

FOLDING DOORS.—The Ritter Folding Door Company, Cincinnati, O., is issuing a standard size catalog very largely given up to illustrations of railway buildings which have recently been equipped with this type of door. These include freight and store houses, engine houses, round houses, shops, garages, and illustrate doors of wood, combination wood and glass or steel applied to either wood, masonry or concrete buildings.

ELECTRICAL APPARATUS.—Among the bulletins recently issued by the General Electric Company, Schenectady, N. Y., are included No. 4633, devoted to the subject of motor generator sets in capacities of from .2 to 1500 k. w., No. 4631 on the subject of series alternating enclosed arc light system, No. 6430 on the subject of direct current portable instruments and a very attractive catalog on fan motors.

CHAIN BLOCKS, ELECTRIC HOISTS, TROLLEYS AND CRANES.—The Yale & Towne Mfg. Co., 9 Murray street, New York City, have issued an attractively arranged and illustrated catalog, describing their triplex, duplex and differential chain blocks and parts; trolleys and cranes, also triplex trolley blocks, overhead track and crabs and winches; electric hoists, including triplex electric hoists and trolleys with current collectors for use with electric hoists.

VALVES.—The American Steam Gauge & Valve Mfg. Co., Boston, Mass., is issuing its 1909 standard size catalog containing 89 pages, which gives illustrations and brief descriptions of a very full and complete assortment of pop valves and relief valves for both pressure and vacuum. These include muffled pop safety valves for locomotives of the latest improved pattern, as well as valves for use at any point where pressure of either gas or liquid is found.

REAMERS.—Cleveland Twist Drill Co., Cincinnati, O., is issuing catalog No. 36, devoted exclusively to the "Peerless" high speed steel reamers, the construction of which was described on page 449 of the November issue of this journal. The catalog contains an illustration of each style, which is accompanied by a table giving the dimensions and prices of each size. The sizes maintained in stock vary by 1/32 in. from ½ to 3 in. in most cases. These reamers are made as hand, core, chuck, shell core, and shell chucking types, any of which can be furnished in solid or expansion styles.

PACKING AND HOSE.—The Revere Rubber Company, 77 Bedford street, Boston, Mass., is issuing two very attractive catalogs, one on packing and the other on rubber hose. The former, which is printed in two colors, shows the great variety of packings for valve stem, pipe fittings, etc., including many special forms for unusual conditions. Each of the large number of styles is illustrated and described and the price is given in each case. The other catalog, which is also printed in two colors, fully describes the construction of the "Revero" hose, which is made in all the usual sizes for water, steam, air, chemical, sand, gas, vacuum, oil, etc. Hose fittings are also shown.

BALL AND ROLLER BEARINGS.—The Standard Roller Bearing Company, of Philadelphia, is issuing catalog No. 24, 5 x 8 in. in size and containing 187 pages. It contains very fully illustrated descriptions of the ball and roller bearings which are designed and manufactured by this company for use in almost every conceivable point where friction occurs. The results of many tests of these bearings in use on various pieces of machinery are given. These include a test of a street car in Syracuse which has been successfully equipped with roller bearing journals. Views of the very complete plant operated by this company in Philedelphia are scattered through the catalog. Both ball and roller bearings, in standard patterns, are maintained in stock and tables are included giving the dimensions, loads to be carried and prices of each size.

FRICTION CLUTCHES.—The Hill Clutch Company, Cleveland, O., is issuing a very attractive catalog devoted exclusively to its friction type of clutches, which are shown in a number of different arrangements. Each type is illustrated and tables are included giving prices for each style and size. This company manufactures friction clutches ranging from 12 in. in diameter, with a capacity of 5 h. p. at 100 r. p. m. to 84 in. in diameter, with a capacity of 1,300 h. p. at 100 r. p. m.

NOTES.

THE RITTER FOLDING DOOR CO.—The shops of the Carolina, Clinchfield & Ohio Ry., at Erwin, Tenn., are to be equipped with Ritter folding doors of wood and glass construction.

ELECTRICAL SHOW.—The Western-Southern Electrical Show will be held in Cincinnati March 13 to 27, 1909. Space for this exhibit can be obtained by addressing Western-Southern Electrical Show, 408 Fourth National Bank Building, Cincinnati, O.

AMERICAN SPECIALTY COMPANY.—John L. Walker, formerly auditor for The Buda Foundry & Mfg. Co., has resigned to accept a position as manager of the "Use-Em-Up" socket department of the above company, 834 Monadnock Bldg., Chicago, Illinois.

DEARBORN DRUG AND CHEMICAL WORKS.—Herbert E. Stone, formerly president of the National Association of Steam Engineers and recently manager of the Pittsburgh office of the Chapman Valve Co., has accepted a situation as manager of sales in the eastern department of the above company, with headquarters in New York City.

FALLS HOLLOW STAYBOLT CO.—The above company announces that Willis C. Squire, 209 Western Union Bldg., Chicago, has accepted the agency for its products for the railway trade in the Chicago territory. Also that Alex S. Mitchell, 45 Broadway, New York, will be agent for the railway and boiler trade in the New York territory.

MEMORIAL TABLET TO AMPERE.—A bronze and tile memorial tablet in honor of the great French scientist, Andre-Marie Ampere, has been set up at the Lackawanna Railroad station at Ampere, N. J., by Dr. Schuyler Skaats Wheeler and was unveiled by the French Ambassador on December 8. Monsieur Ampere was born in 1775 and died in 1836, and this tablet forms probably the only memorial raised in his honor in America.

SNOW PLOWS.—The Russell Car and Snow Plow Company, Ridgeway, Pa., announces that among its recent shipments were a double track, size 2, plow for the Buffalo, Rochester & Pittsburgh Railroad, and electric plows, size 6, for the Bangor Railway & Electric Company and the Lewiston, Augusta & Waterville Street Railway and a combination car and snow plow, with double track steel noses, for the Ottawa Electric Company.

MEETING OF THE A. S. M. E.—The January meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York, on Tuesday evening, January 12. The paper will be by Carl G. Barth of Philadelphia, upon the "Transmission of Power by Leather Belting," which will be illustrated by lantern slides. Valuable charts have been prepared by the author for the solution of belting problems and will be given in the paper.

OIL FUEL ON HYDRAULIC DREDGES.—The U. S. Army has just placed in commission the second of two very large hydraulic dredges required for service in the Gulf of Mexico. The first one built, the "General C. B. Comstock," was placed in commission six years ago and was fitted for burning oil for fuel, the entire fuel equipment being furnished by Tate, Jones & Co., Inc., of Pittsburg. The service of that vessel has led to the equipping of the new one, the "Galveston," which has four boilers and 2,000 indicated horse power, in the same manner, the apparatus being furnished by the same company.

A NEW CORRESPONDENCE SCHOOL.—The Modern System Correspondence School Company, with offices at 6 Beacon street, Boston, Mass., has been organized and Oscar E. Perrigo has been elected president and educational director. This school will give practical instruction in the subjects of modern cost systems; shop methods and systems; shop construction, development, organization and management; factory and commercial office systems; foundry systems; mechanical drawing and engineering systems, and such other allied subjects as may be added from time to time. The New York office is at 132 Nassau street.

TERMINATION OF RECEIVERSHIP.—The Westinghouse Electric & Mfg. Company again became the property of the stockholders on December 5, after having been in the hands of the receiver since October 23, 1907. It is stated that this is the most successful receivership that has ever taken place, the operations of the company during the time of receivership showing a net profit of over $1,000,000. The newly elected officers consist of, president, George Westinghouse; temporary chairman of executive committee, E. C. Converse; first vice-president, E. M. Herr; second vice-president, L. A. Osborne; secretary, Chas. A. Terry, and treasurer, T. W. Siemon.

THE HAMMER BLOW FROM INCORRECT COUNTERBALANCE

H. H. VAUGHAN.

The generally accepted solution of a consideration of the action on the rail of a wheel containing counterbalance is that of a variable pressure between the rail and the wheel equalling the static weight on the wheel, added to or reduced by the vertical force due to the action of the unbalanced weight. Thus in Fig. 1 if OA represents the time of one revolution, BC the pressure between the rail and the wheel due to the weight on the wheel, OB and ODAE the vertical force due to the action of the overbalance, the result and pressure between the rail and the wheel is shown by the line BFG and equals the ordinate of the shaded area at any time.

Should the overbalance be excessive and the speed so high that the vertical force caused by the overbalance exceeds the weight on the wheel, there may be a negative pressure between the wheel and the rail, or in other words, a force tending to lift the wheel, which condition is shown in Fig. 2, where the cross hatched portion below OA represents an upward force which tends to lift the wheel and attains a maximum value TP at

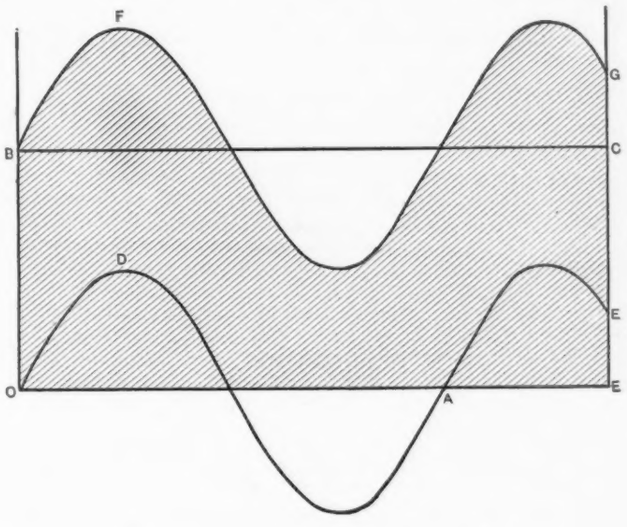


FIG. 1.

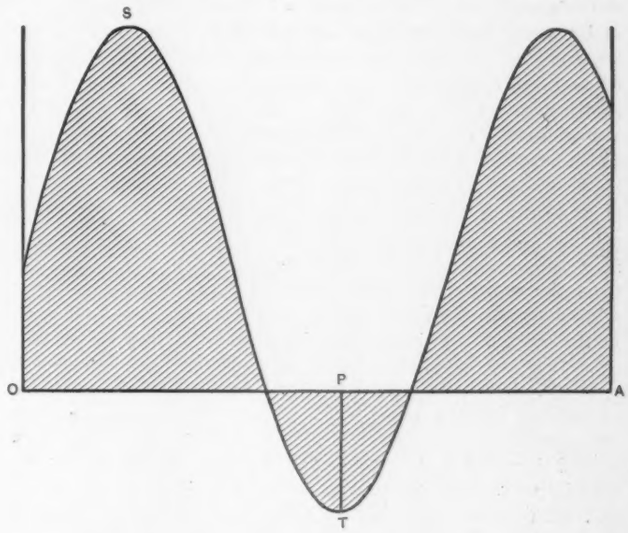


FIG. 2.

the instant when the counterbalance is vertically upwards. For a numerical example suppose the weight on the wheel is 20,000 pounds and the maximum vertical effect of the overbalance is 25,000 pounds. The pressure on the rail will become 45,000 pounds at the point S, while at T there will be a force of 5,000 pounds tending to lift the wheel, and that the wheel does lift under the action of this force is well shown from the experiments on the Purdue and St. Louis testing plants. The greatest pressure on the rail occurs when the counterbalance is vertically downwards, and as this in many cases of improperly balanced engines reaches such figures as 50,000 to 60,000 pounds, the damage that has occasionally been caused to the rail when such engines have run at specially high speeds, has been ascribed to this great downward force. A consideration of the diagrams shows that however great this force may be at this point, its application is entirely gradual and it cannot possibly partake of the nature of a blow given by a falling weight, however high the speed, as the pressure between the rail and the wheel gradually increases from nothing or a comparatively small amount until it reaches its maximum and then decreases, and it has therefore become usual to regard the hammer blow, so often mentioned in connection with counterbalance, as a misnomer, and to ascribe the damage that may occur, to the high pressures which exist, rather than to the effect of an actual fall of the wheel on the rail.

In the early part of 1908 a serious case of damaged rails occurred on the Canadian Pacific Railway, the rails being sharply bent for about a mile, on both sides at intervals about equal to the circumference of a driving wheel. The damaged spots were carefully measured over a considerable distance, averaged, and the diameter of the wheel so found corresponded with that of an engine which had made a very fast run over the damaged track the day previous. The wheels of this engine were taken out and the main drivers found to contain an excessive amount of overbalance, actually amounting to about 1,000 pounds. As the weight on these wheels was 22,000 pounds, the force on the rail at the speed estimated varied from 57,000 pounds to an upward force of 13,000 pounds. A portion of the rail was experimented with in a testing machine and it was found impossible to bend it in the same manner as had occurred on the track, with different centers of supports and with loads as high as 200,000 pounds While the cause of the damage was thus located, the method by which it was effected was still not apparent, and a general disbelief in the calculations of the forces caused by the unbalanced weights on the wheels was the natural result. It then occurred to the writer to investigate the action of the wheel when lifted from the rail by the upward force caused by the overbalance, with results that are interesting and to a large extent explain the action which takes place.

The wheel is taken as a mass of 3,200 pounds weight, pressed down by the spring with a force equal to the static weight on the rail, less its own weight, running on rigid track and acted upon by the forces caused by the overbalance. As an example the speed was assumed to be 300 revolutions per minute, the weight on the rail 20,000 pounds and the force due to the overbalance 25,000 pounds, so that the force tending to lift the wheel attained a maximum of 5,000 pounds. The mathematical discussion which applies to any set of conditions is given below, and the results are shown in Fig. 3 for this particular example.

The horizontal dimensions in this diagram indicate the movement of the wheel in degrees, 0° being the position of the wheel

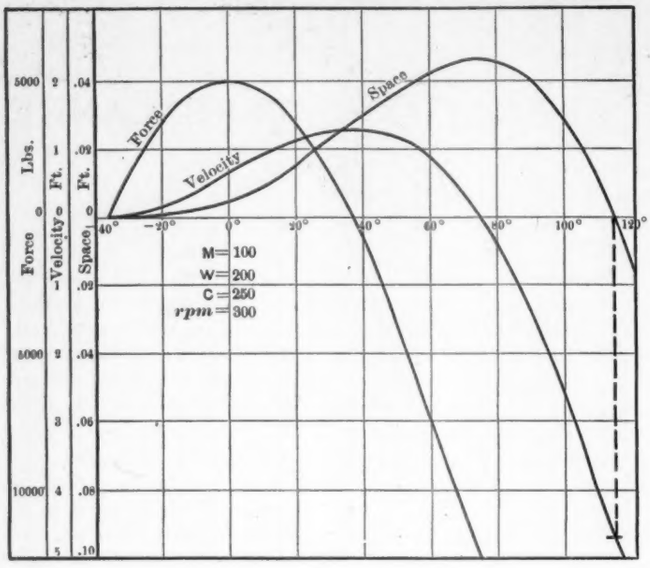


FIG. 3.

when the counterbalance is vertically upwards, while the vertical dimensions indicate to three different scales, the forces acting on the wheel, the velocity of the wheel upwards and its upward movement. Thus, at about — 37½°, or when the center line of the counterbalance makes that angle with the vertical, the upward force due to the overbalance equals the weight on the wheel, and beyond that exerts an upward force on the wheel, tending to lift it, which becomes a maximum of 5,000 pounds at 0° and zero again when the counterbalance has moved 37½° past the center. The wheel then commences to be acted upon by a downward force due to its weight and the force of the spring which becomes greater than the effect of the counterbalance. Since the latter continues to decrease and at 90° becomes zero and later in its turn acts downward, this force increases rapidly. Further consideration indicates that the upward velocity of the wheel, zero at —37°, gradually increases until the wheel has turned to 37°, when its upward velocity is a maximum, since, while the forces acting on it upward have been decreasing from 0°, they have still been acting to increase its upward velocity. As the downward forces become reversed they first destroy this upward velocity which becomes zero at about 75°, after which they impress on it an increasing downward velocity until the wheel reaches the rail. To find the point at which this takes place, it is necessary to plot the space line or that showing the movement of the wheel vertically upwards from the rail. This commences with zero at —37°, gradually increasing to 0.0465 feet or about .55 inch at 75°, at which point the upward velocity is zero and the upward movement has attained its maximum. The wheel then begins to return to the rail, its movement becoming zero again, or in other words, striking the rail at 115°, and by referring to the velocity curve, it will be seen that at the point the downward velocity is 4.7 feet per second. This velocity corresponds to that gained in dropping freely through a height of 0.36 foot, or about 4½ inches, and as the weight is 3,200 pounds, there is an actual, but not severe, blow.

It is interesting to note that this diagram explains completely the results obtained on testing plants, and with wire run under the drivers, in which W. F. M. Goss has noted that the wheel appeared to drop more quickly than it went up, and at a considerably greater distance from the center, and it is evident that this should be so. The movement of the wheel does not coincide with the variation in the force. As long as the force is upwards the wheel is acquiring an upward velocity and this velocity does not become zero until the downward forces have acted on the wheel for a sufficient time to destroy it. In the same way, the upward movement goes on increasing not only until the upward velocity decreases, but until it is destroyed and the wheel does not return to the track until the downward velocity has attained a very considerable amount.

The diagram in Fig. 4 shows similar curves plotted at 320 revolutions for the engine mentioned as having caused the damage to the rail on the Canadian Pacific. This is of course an exceptionally bad case, but it will be seen that the wheel did not return to the track for 177°, when it had a downward velocity of 17½ feet per second, corresponding to a free fall of 4¾ feet, from which height a weight of 3,200 pounds would certainly deliver a blow of sufficient energy to account for the effects observed.

In an extreme case of this nature, however, the method of analysis employed gives results that are greater than would actually occur, since the force acting down on the wheel is not constant, but would increase as the wheel moved upwards and deflected the spring. For instance, if the latter had a deflection of 0.2 foot under the working load of 18,800 lbs., the downward force with any upward movements of the wheel would equal

$$3200 + 18800 \left(\frac{s + 0.2}{0.2}\right)$$

in place of a constant amount of 22,000 pounds, and the acceleration equation would then become

$$\frac{d^2s}{dt^2} = C \cos kt - \left[3200 + 18800 \left(\frac{s + 0.2}{0.2}\right) \right]$$

This expression involves s and becomes exceedingly complicated to integrate, but the effect of including it would be to diminish the upward movement and slightly reduce the striking velocity. In the first case its influence is inappreciable as the upward movement is small, but in the second it would certainly reduce this, and account for the box not striking the frame. An exact solution would in addition allow for the elasticity of the track, and this in its turn would apparently increase the velocity of the blow, although an equation involving it would probably be too complicated to treat mathematically except by an expert.

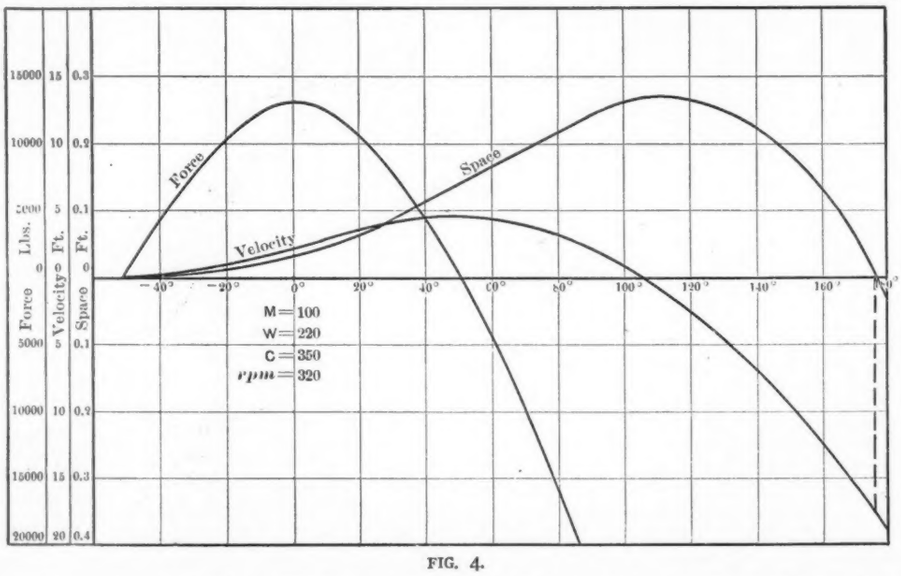


FIG. 4.

While, however, the solution here given in Fig. 4 may not be exactly correct, the actual striking velocity being lower than that calculated, there is no doubt that it is of considerable magnitude and probably from 12 to 15 feet per second, and an absolute hammer blow is therefore accounted for which is of sufficient intensity to explain the damage that has occurred.

It is interesting to note that in extreme cases the wheel does not return to the track or the blow occur until the wheel has

moved to a position where the counterbalance is within 20° or 30° of being vertically downwards and the popular connection of this blow with the downward movement of the counterbalance is thus explained.

The result of these calculations would emphasize the danger of an unbalanced force which could equal the weight on the wheel. On the usual assumption that the maximum speed in miles per hour equals the diameter of drivers in inches, this would restrict the overbalance in any wheel to 2½ per cent. of the weight on the wheel and to be entirely safe the practice on the Canadian Pacific Railway is now to limit it to 1¼ per cent. and to make it 1 per cent. if possible.

MATHEMATICAL ANALYSIS.

When counterbalance is vertically upwards $t = 0$

Let w = acceleration due to downward force of spring and weight of wheel, acting on mass of wheel

c = acceleration due to maximum value of force caused by overbalance, acting on mass of wheel

s = vertical movement of wheel, from rail, feet

t = time, seconds

kt = angular movement of wheel, radians

Then, $$\frac{d^2s}{dt^2} = c \cos kt - w$$

$$\frac{ds}{dt} = \frac{c}{k} \sin kt - wt + C$$

$$= 0 \text{ when } t = -t_1, \text{ when } \cos kt_1 = \frac{c}{w}$$

$$\text{Then } C = \frac{c}{k} \sin kt_1 - wt_1$$

$$\text{And } \frac{ds}{dt} = \frac{c}{k} \sin kt + \frac{c}{k} \sin kt_1 - wt - wt_1, \text{ from which the velocity curves are plotted}$$

$$s = -\frac{c}{k^2} \cos kt + \frac{ct}{k} \sin kt_1 - \frac{wt^2}{2} - wtt_1 + C$$

$$= 0 \text{ when } t = -t_1$$

$$\text{Then } C = \frac{ct_1}{k} \sin kt_1 + \frac{c}{k^2} \cos kt_1 - \frac{wt_1^2}{2}$$

$$\text{and } s = \frac{c}{k^2}(kt_1 \sin kt_1 + \cos kt_1) - \frac{wt_1^2}{2} - \frac{wt^2}{2} + t\left(\frac{c}{k} \sin kt_1 - wt_1\right) - \frac{c}{k^2} \cos kt_1$$

from which the space curves are plotted.

RAILROADS WANT FAIR TREATMENT.

The railroad system of the country has been built up by individual energy working with capital that was invested because it expected a profit in the enterprise. Capital has ceased to be generally available for this work at a time when its co-operation is greatly needed. The return of prosperity to the transportation business and to all other business, since the connection between them is direct and intimate, is conditioned upon such a restoration of confidence as will again permit and promote liberal investments. And that will happen only when the public is convinced that capital put into railroad securities will have the same protection against unjust or unfair attack, the same right to earn a proper return, as capital invested in other occupations enjoys.

The country, in fact, is waiting to see what is to be the attitude of public authorities, legislatures, commissions and courts toward the railroad interest. It needs and asks no favors; it is entitled to fair play, and the capital employed in it to a reasonable profit. When this appears certain, and public policies are framed accordingly, not only transportation, but all other industry, will experience a real return of prosperity. The material welfare of the nation will be promoted by every expression of determination on the part of individuals and associations representing great interests to secure that just treatment and that security without which capital withdraws itself, every form of industry declines, and all the people suffer loss.—*From a letter by J. J. Hill to the Hoboken Board of Trade.*

CARS AND LOCOMOTIVES BUILT IN 1908.†

To understand the condition of the car and locomotive building business fully during the past year, it is necessary to study both the number of orders placed for equipment during this period and also the number built. The orders placed, which are fully reported in another column of this issue, reflect both business conditions throughout the year 1908 and expectations of better conditions during 1909. The amount of equipment actually built during the year, on the other hand, shows only actual conditions unlightened by hope of the future, since actual recovery of business started too late in the year to show in the form of completed cars and locomotives. The following figures are also interesting in that they are compiled from returns from equipment building companies only, and do not include the output of railway companies' shops, the operation of which through the year has helped in giving somewhat of a market for labor and makers of railway supplies.

In 1907, car and locomotive builders worked at full capacity throughout the year on orders placed in the early part of that year. By the end of the year, however, the full effects of the depression were being felt, and comparatively few orders were carried over into 1908. Last December, officials of representative companies estimated that their orders on hand would keep them busy at full capacity for from two to four months only. Where possible, working time and forces were cut down so as to keep plants running on part time for as long a period as possible on completing such orders as could be delayed.

During the past year 35 car building companies in the United States and Canada built 78,271 cars, which is only 27 per cent. of the number built in 1907. These figures include subway and elevated cars, but not street railway and interurban cars. Of the cars built in the United States, 66,751 were freight cars for domestic service, 1,206 freight for export, 1,566 passenger cars for domestic service and 71 passenger for export. Canada built 8,593 freight cars for domestic service, 5 freight for export, and 79 passenger cars for domestic service. In 1907, Canada built 9,159 freight cars and 106 passenger cars.

The following table shows the cars built during the last 10 years:

Year.	Freight.	Passenger.	Total.
1899	119,386	1,305	121,191
1900	115,631	1,636	117,267
1901	136,950	2,055	139,005
1902	162,599	1,948	164,547
1903	153,195	2,007	155,202
1904	60,806	2,144	62,950
1905	165,455	2,551	*168,006
1906	240,503	3,167	*243,670
1907	284,188	5,457	*289,645
1908	76,555	1,716	*78,271

* Includes Canadian output.

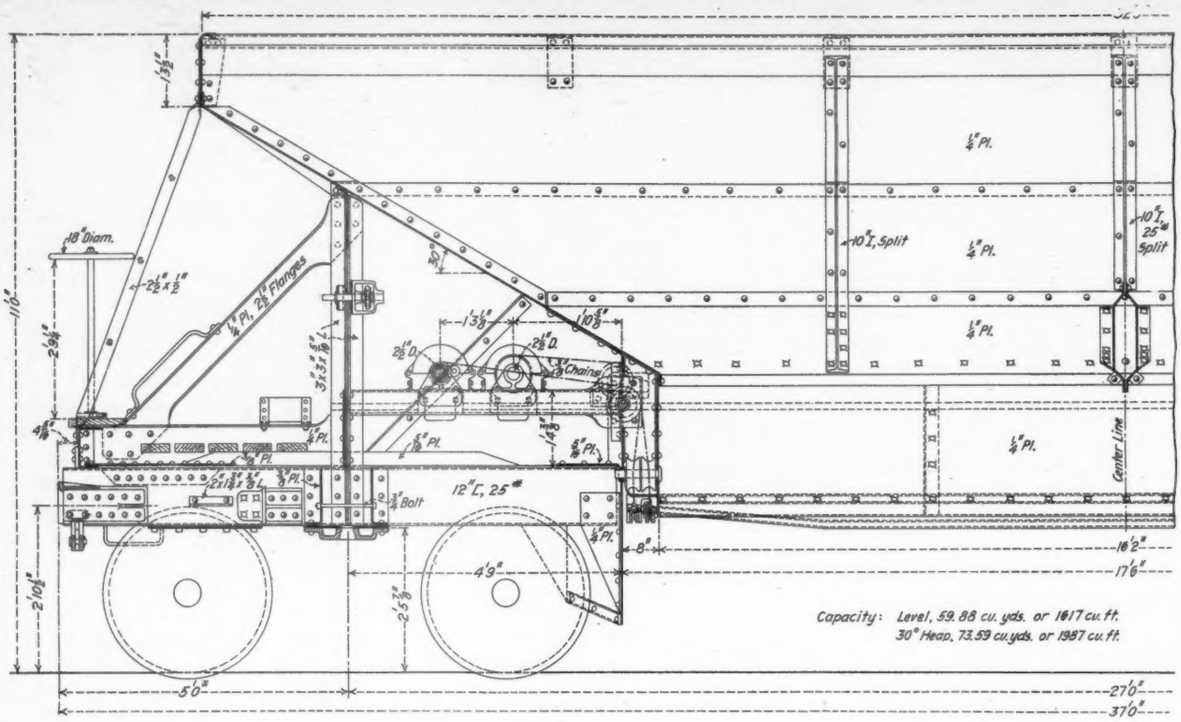
Returns from 11 locomotive builders in the United States and Canada show a total of 2,342 engines, about the same relative falling off as in the cars built. Of the 2,124 built in the United States, 1,668 were for domestic use and 456 for export. These figures include 245 electric and 79 compound locomotives. The Canadian engines, 218, were all for domestic service. Of these 20 were compound.

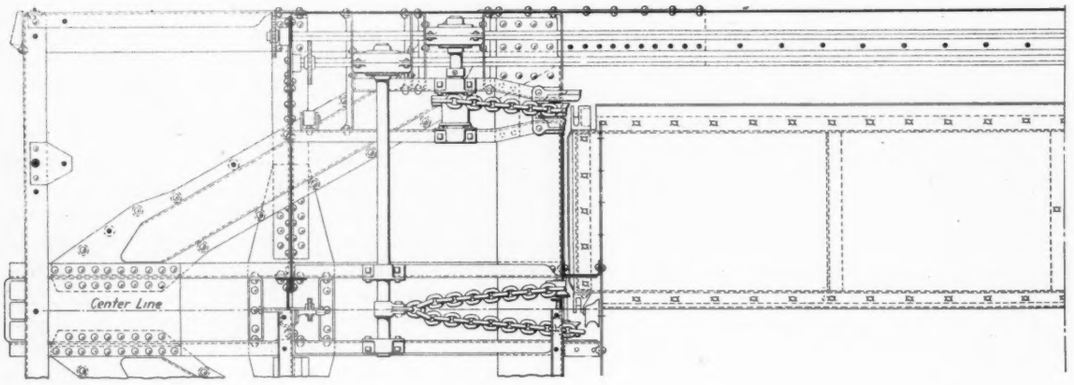
Comparisons for the last 16 years are given in the following table:

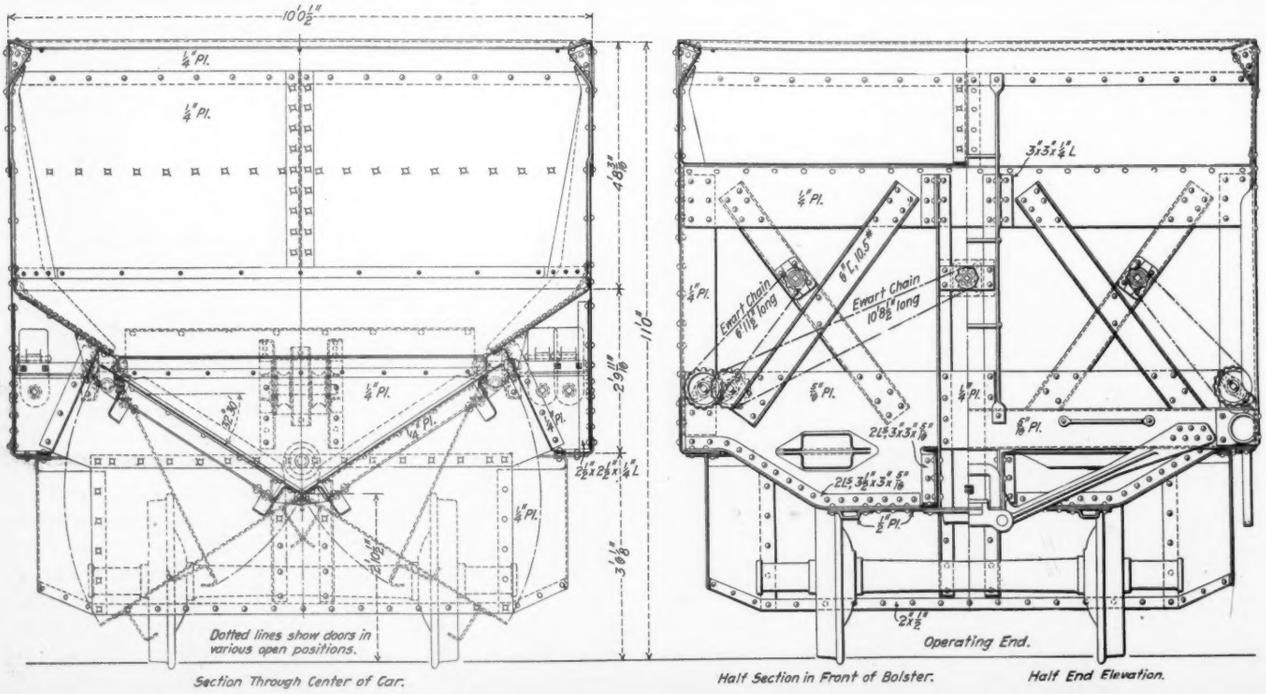
Year.	No. built.	Year.	No. built.	Year.	No. built.	Year.	No. built.
1893	2,011	1897	1,251	1901	3,384	1905	*5,491
1894	695	1898	1,875	1902	4,070	1906	*6,952
1895	1,101	1899	2,475	1903	5,152	1907	*7,362
1896	1,175	1900	3,153	1904	3,441	1908	*2,342

*Includes Canadian output.

† From the Railroad Age Gazette, Dec. 25, 1908.







Section Through Center of Car. Half Section in Front of Bolster. Half End Elevation.

SECTIONAL ELEVATIONS, PLAN AND END ELEVATION OF SUMMERS STEEL HOPPER CAR—UNION RAILROAD.

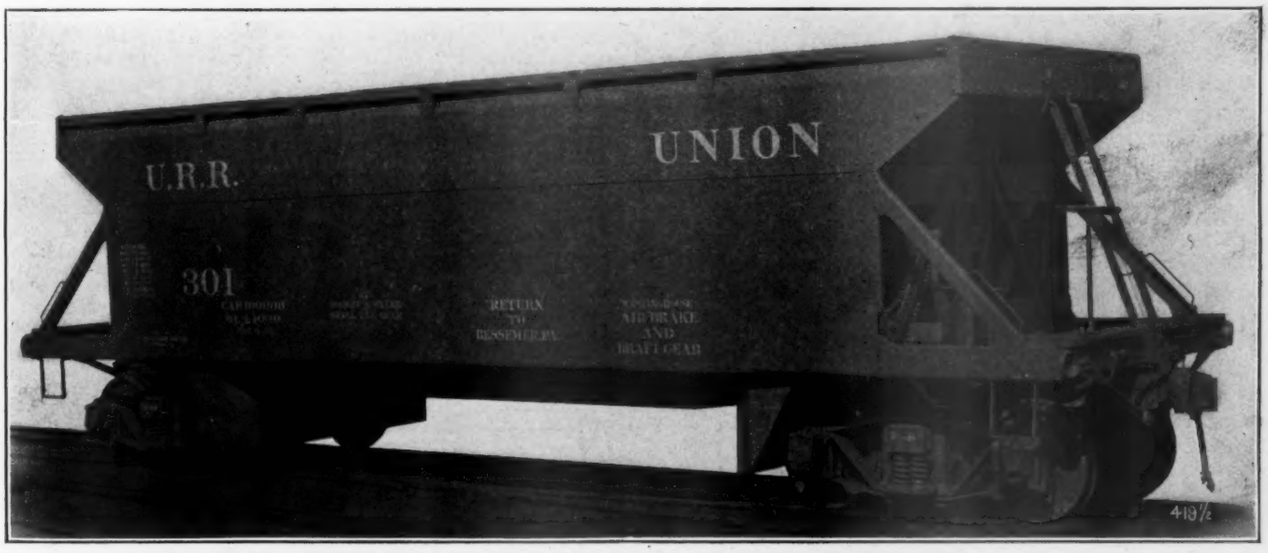
SUMMERS' STEEL HOPPER CAR

These cars are of the hopper type and have door openings 16 ft. 2 in. long and varying in width, depending upon the conditions of unloading, as shown by the sketches, but in some cases amounting to as much as two-thirds of the width of the car. These doors are controlled from one end of the car, and by the proper manipulation of three cranks the combinations of unloading shown on the sketches may be obtained. All of the load may be discharged clear of the track on either side of it, or part of it may be discharged on either side, or all of it may be dumped in the center. The amount of the flow, in any of these cases, may be regulated by stopping the doors in a partially opened position, where it will remain without locking.

The cars were designed to carry a load of 100,000 lbs. and have a cubic capacity, when loaded level, of 59.8 cu. yds., or 1,617 cu. ft. With a 30 deg. heap they have a capacity for 73.59 cu. yds., or 1,987 cu. ft. With this capacity, and the above mentioned advantages for unloading, it is remarkable to find that the car weighs only 45,000 lbs., although it is as strong, and probably stronger, than most of the 100,000 lb. hopper cars in service. While it is especially adapted for construction work and for handling coal and ore, and material of this kind, it may be used advantageously for any purpose to which the ordinary hopper car is suited.

The features of construction are clearly shown on the drawings. The design is unique from the fact that the car has no center sills, the draft sills extending from the end sills to the hopper only. These sills transmit the pulling and buffing stresses to the side girders through the pressed steel diagonal braces. The side construction is very strong and rigid, and, as shown by the cross-sectional view, the metal is so distributed as to accomplish the desired results with a comparatively small amount of metal. The peculiar shape given to the top of the side sheet makes this member very stiff at a point where many of the steel hopper cars have proved defective in the past. The sides are tied together at the middle by the pressed steel stiffeners. The vertical side stiffeners are placed on the inside and consist of 10 in., 25 lb., I-beams split, thus forming a T with the projecting part shaped to give the greatest strength where it is most needed.

The drop doors are of ¼ in. plate and are carefully reinforced to stand up under the severe service to which they are subjected. The guards at the ends of the doors and in front of the trucks are used to spread the material which may be dumped between the tracks, and to push it out from the track when dumped at the side.



SUMMERS STEEL HOPPER CAR, 100,000 LBS. CAPACITY—UNION RAILROAD.

The draft sills are 12 in., 25 lb., channels; Westinghouse friction draft gear is used, the draft lugs being of cast steel. The extension of the side sills and the ends of the end sills receive additional support from the diagonal brace which extends upward to the side sheets. The coupler carrier iron is of cast steel and is secured by pins to two cast steel arms, which are riveted to the end sill channels.

The Union Railroad Company (a constituent of the Carnegie Steel Company) has over 600 of the cars now in operation and a number of other steel-producing concerns are also using them and increasing their number by additional orders from time to time.

The Union Railroad made a fill in the past year, raising the

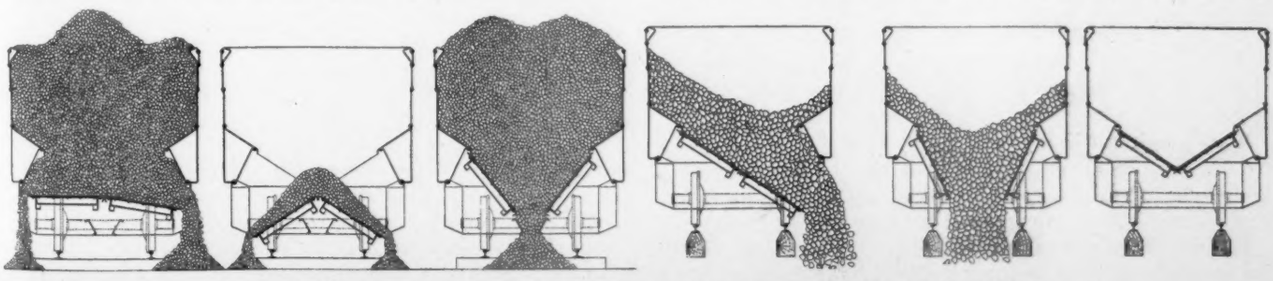
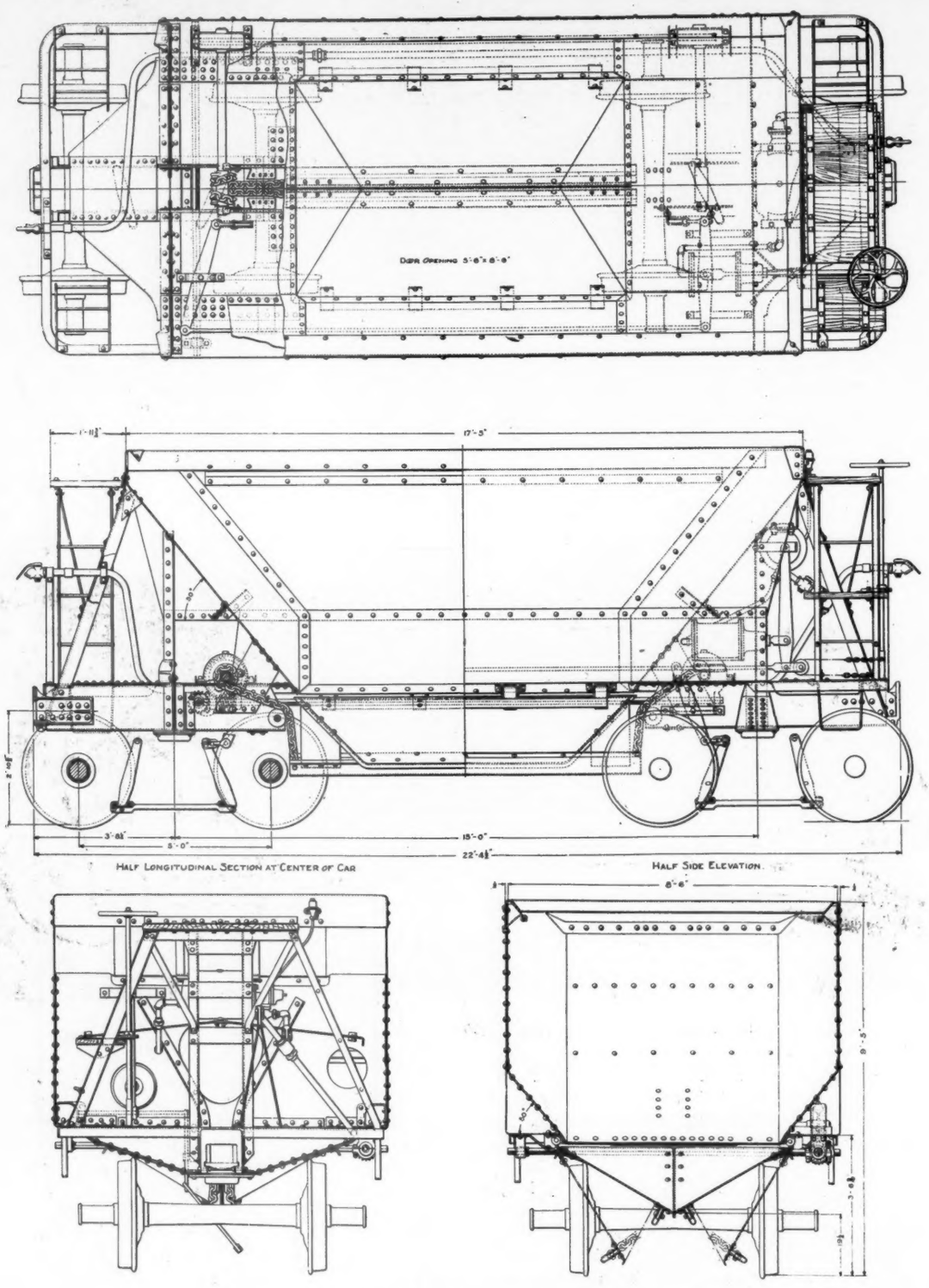


ILLUSTRATION OF WAYS IN WHICH THE SUMMERS STEEL CARS CAN BE UNLOADED.



SUMMERS STEEL ORE CAR—DULUTH AND IRON RANGE RAILROAD.

level of a classification yard some 20 feet with over two million cubic yards of filling material. The use of these cars for this work materially reduced the cost of handling refuse material over that of other years notwithstanding they were operating at a great disadvantage on account of having to do the work and keep traffic open through the yard at the same time.

A fill which can be made by discharging the load all at one side and follow up the fill by moving the track over, is where this design of car is especially advantageous, and under such conditions will save its cost in a comparatively short time.

This type of car has also proven itself to be specially adapted for ore traffic and the illustration above shows a design, 800 of which are now under construction, for the Duluth & Iron Range Railroad. This order followed a long experience with a sample car.

Of course, the ore car, while following the same general features, differs from the regular car in many details. The most noticeable feature is in the slope of the sides, which are at an angle of 50 degs. instead of 30 degs. The cubical contents, of course, is considerably smaller for the same weight capacity, giving both a shorter and a lower car and one which, in the case of the sample car, weighed but 32,100 lbs.

The cars of both types are equipped with standard arch bar trucks and were designed by E. W. Summers, president of the Summers Steel Car Company, Farmers' Bank Building, Pittsburg, Pa.

WEIGHT DISTRIBUTION OF MALLET ARTICULATED LOCOMOTIVES

H. M. Sloat.

The calculation of the weight distribution of any type of locomotive involves the center of gravity and the calculation of the center of gravity involves the knowing or estimating the weight of each part and its distance from some assumed point. On account of the articulated feature of Mallet design, the two systems require separate consideration.

The center of gravity of each system is found in the usual manner, the front system being considered as comprising all the parts forward of the point of articulation, such as the low pressure cylinders, front frames, front bumper, guides, etc., and the rear system as comprising the remaining parts, including the boiler. In these calculations only the weights above the springs are considered, *i. e.*, the live load.

Since the design of an articulated compound locomotive calls for the same tractive effort from each set of cylinders, which means that the same adhesive weight should exist in each system, it is, of course, necessary that the total weight should be divided equally between the two groups of wheels, and since the rear system is by far the heavier, the front system must, therefore, support one-half of the difference between the two to ensure this distribution.

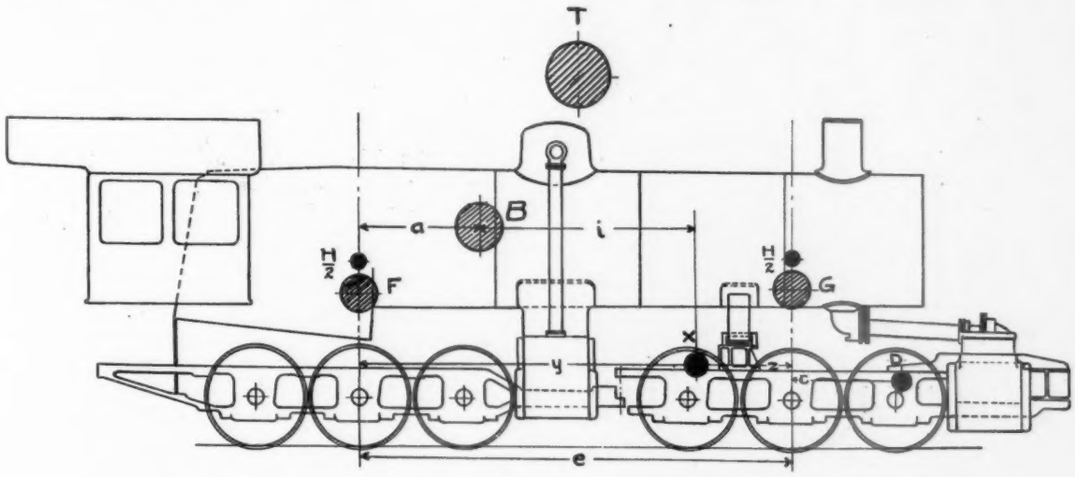


FIG. I.

The point where this weight is to be supported on the front system is readily located by determining a lever arm of such length that the moment obtained by multiplying it with the weight will equal the moment obtained by multiplying the weight of the front system by the distance of its center of gravity from the center of the wheel-base of this system. This point may be called the "Virtual Supporting Point" of the rear system on the front engine, and is shown at distance z. Thus $Xz = Dc$ (Fig. 1.). As the moments are equal, the tilting effect of the system produced by its center of gravity falling so far ahead of the middle point of the wheel-base will now be balanced.

Figure 1 shows clearly how the weight is distributed through the system. The balls represent weights, the various sizes being indicative of the amount considered as acting at that particular point. Thus, D is the weight of the front system shown at its center of gravity; X is the proportion of the weight brought over to the front system to equally divide the total weight of the engine; G equals the sum of D and X; F is the weight carried by the rear system; B equals the sum of F and X, and T represents the total weight of the engine or the sum of $F + \frac{H}{2} + G + \frac{H}{2}$, where $\frac{H}{2}$ equals the dead weights of each system.

It is obvious that in order to obtain the desired weight at the virtual point of support, the center of gravity of the rear system can be located in but one place. To determine this location we divide the moment of the rear system—obtained by multiplying the weight falling on the virtual point of support (X) by its distance from the center of the wheel-base of this system (y)—by the total weight of the system (B). The result is the distance ahead of the center of the rear wheel-base at which the center of gravity acts.

But it is also evident that the actual center of gravity may not coincide with this point, and when such is the case, the location of the boiler is shifted, or the position of the other heavy parts, such as the cylinders, frames or castings is moved, or the wheel-base changed until the center of gravity is moved sufficiently. An approximate plan is laid out and then modified until the desired conditions are reached.

The proportion of the total weight supported by the front and back systems is readily found by considering the rear system as a beam carrying a concentrated load and resting on two supports, *i. e.*, the load is divided according to the respective distances of the supporting points from its point of application. This is shown by the following equation:

$$\text{Front system,} \quad X = \frac{B}{y} a \text{ and } G = X + D$$

$$\text{Back system,} \quad F = \frac{B}{y} i$$

This, when added to the dead weight of the respective systems, will equal the total rail load of that system and one-half the total weight of the engine.

The actual or sliding support through which the weight is brought on the front system, is shown in Fig. 1 located between the second and third pairs of drivers; it is not practical to place this support coincident with the virtual point of support, because then the front engine would be unstable and tip one way or the other by changes due to inertia in stopping or starting or the slightest disturbance due to change of grade. It should be placed a sufficient distance ahead of the virtual point to insure stability. But since the lever arm from this support to the center of the rear wheel-base is now lengthened, the weight carried to the

front system is reduced and thus actually Xz will not equal Dc and the front engine will consequently tend to tip forward. To correct this disturbance, a pair of vertical hanger or suspension bolts is applied just forward of the point of articulation, between the upper member of the frame at the extreme rear end of the front engine, and the lower member of the frame at the extreme front end of the rear engine. By tightening these bolts, the proper alignment of the front engine may be adjusted and the actual supporting point brought back, so that in effect it coincides with the virtual. This reduces the pressure on the sliding support and imposes load on the bolts in proportion to the respective distances of the two supports from the virtual supporting center. These bolts are shown in Fig. 2. The disturbance due to grade or inertia may also be reduced by providing two supports, one on each side of the virtual.

The application of both front and rear trucks will not disturb the position of the centers of gravity, for they will take a certain percentage of the load depending on the position of their equalizing arms, a like amount being taken off the drivers on each system. In case, however, only a front truck be added, this will necessitate shifting the boiler or cylinders ahead in order to keep a sufficient weight on the front drivers thus compensating for the weight taken off by the truck. The proportion of weight falling on the truck is determined by the same method used when considering a mogul or a consolidation type of locomotive.

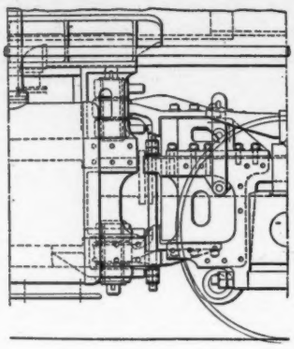


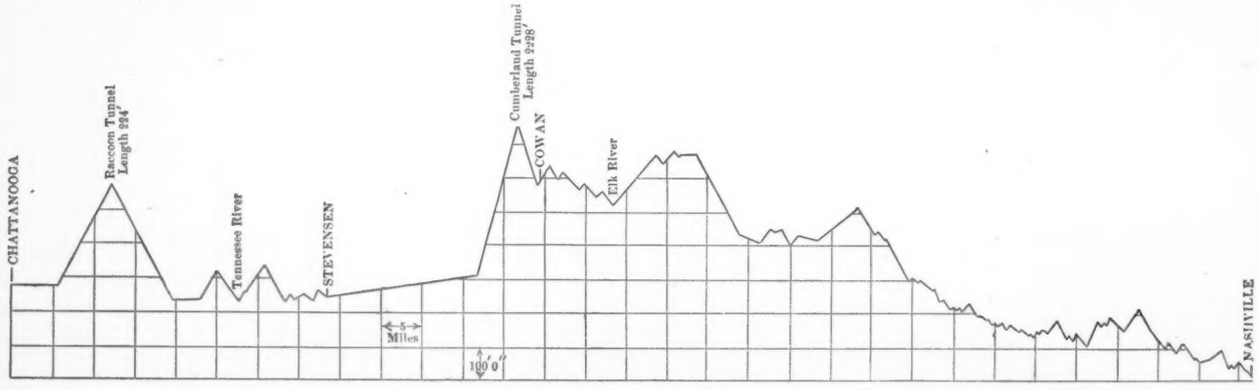
FIG. 2.

BALANCED COMPOUND PASSENGER LOCOMOTIVE

NASHVILLE, CHATTANOOGA AND ST. LOUIS RAILWAY.

About three years ago the Baldwin Locomotive Works completed an order of three balanced compound passenger locomotives of the ten-wheel type for the Nashville, Chattanooga and St. Louis Railway which gave so good an account of themselves that a fourth engine was ordered from the same drawings in 1906 and a further order of three more have recently been delivered. The last order differs from the previous ones in the substitution of the Walschaert valve gear for the Stephenson, but in other respects is practically a duplicate. The design throughout is conservative and represents a modernized example of the type of passenger locomotive which was very popular ten years ago and is still being successfully operated in large numbers, principally on branch lines, with probably a smaller maintenance cost per engine mile than any later type of passenger power. The modernizing process consists in applying balanced compound cylinders and Walschaert valve gear together with some minor features, as electric headlight, pneumatic sanders and bell ringer, etc. The compound cylinders permit a very desirable increase in capacity while still retaining the narrow firebox, wagon top boiler with its many advantages from a maintenance standpoint. The advantages of the Walschaert valve gear over the Stephenson, particularly on a locomotive with a cranked axle, are so evident that its application needs no explanation. The other features are, of course, improvements without any counteracting disadvantages and the net result is a locomotive which retains the best features of the old with some of the best features of the new era of design.

These locomotives are now operating over the Chattanooga division, a profile of which is shown in an accompanying illustration, where the ruling grade negotiated by a single locomotive is 53 ft. per mile and the maximum grade, between Stephenson and Cowan, where a helper engine is used, is 105 ft. per mile. The division is 151 miles long. Train No. 1 makes the run in five hours and ten minutes, including 27 stops. The regular train consists of a baggage car, mail car, express car, four coaches and two sleeping cars and has a weight of 420 tons. Train No. 3 makes the run in five hours and fifteen minutes, with 12 stops, and normally weighs 450 tons. Extra sleepers, however, are frequently added, giving a 12 or 13-car train, but the locomotives have sufficient reserve capacity to still maintain their schedule, which was altogether out of the question with simple engines under these conditions. Mr. F. H. Scheffer, superintendent of machinery at Nashville, states that in a general way the running repairs are about one-third more than for a simple engine, although some small changes made in the last order will probably largely reduce this percentage, but, since the engines save coal and satisfactorily perform the service demanded, there is no objection to the increased maintenance cost, and balanced compounds are very popular in that district.



PROFILE OF THE CHATTANOOGA DIVISION OF THE NASHVILLE, CHATTANOOGA & ST. LOUIS RAILWAY.

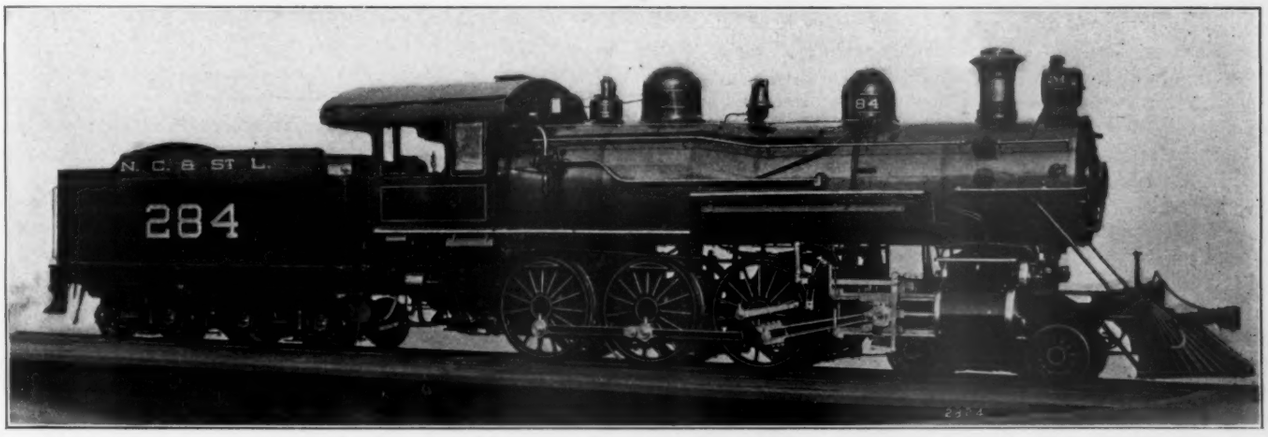
This design of balanced compound cylinders has been illustrated and described several times in these columns and is too well known to require further description. The present example contains no unusual features. The piston valves are 15 in. diameter and are located directly over the frames. This requires

the introduction of a rocker to transfer the motion from the plane of the valve gear to the valve. It is placed just back of the cylinders and has two upwardly extending arms, the outer one connecting to the combination lever at the same point the valve stem connection is made in the usual design on simple engines.

The crank axle is of the built up type with a cast steel center web which was illustrated in this journal in August, 1906, page 308. The main rods are approximately 75 inches in length.

The main frames are cast steel 4 inches wide and the single bar front frames are iron with a comparatively light section made possible by the use of balanced cylinders which very decidedly reduce the stress in them as compared to what it would be with simple cylinders.

The boiler is of the well-known narrow firebox, wagon top type and measures 64 in. outside diameter at the front ring. The mud ring is but 3 in. wide at the sides and back and the side



BALANCED COMPOUND TEN-WHEEL PASSENGER LOCOMOTIVE—N., C. & ST. L. RY.

water legs are narrow throughout, widening to only about 4 inches at the crown sheet. In the back water leg the space is increased to 6¼ inches at the crown sheet.

The O'Connor firedoor flange is used and flexible staybolts have been fitted in the breakage zones. The tubes number 256 and are 2¼ in. diameter and 17 ft. long. The bridges are approximately ¾ in. The tube heating surface gives a ratio of 73.2 to the grate area.

The general dimensions, ratios and weights are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. Coal
Tractive effort	29,200 lbs.
Weight in working order	170,000 lbs.
Weight on drivers	125,000 lbs.
Weight on leading truck	45,000 lbs.
Weight of engine and tender in working order	280,000 lbs.
Wheel base, driving	12 ft.
Wheel base, total	26 ft.
Wheel base, engine and tender	55 ft. 2 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.28
Total weight ÷ tractive effort	5.81
Tractive effort × diam. drivers ÷ heating surface	705.00
Total heating surface ÷ grate area	78.50
Firebox heating surface ÷ total heating surface, per cent	6.80
Weight on drivers ÷ total heating surface	45.80
Total weight ÷ total heating surface	62.00
Volume equiv. simple cylinders, cu. ft.	10.20
Total heating surface ÷ vol. cylinders	268.00
Grate area ÷ vol. cylinders	3.40

CYLINDERS.

Kind	Bal. Comp.
Diameter and stroke	16 & 27 × 26 in.
Kind of valves	Piston
Diameter of valves	15 in.

WHEELS.

Driving, diameter over tires	66 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	10 x 10 ½ in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	5½ x 12 in.

BOILER.

Style	W. T.
Working pressure	210 lbs.
Outside diameter of first ring	64 in.
Firebox, length and width	120 x 41⅛ in.
Firebox plates, thickness	S. & B. ⅛, C. 7/16, T. ½ in.
Firebox, water space	F. 4, S. & B. 3 in.
Tubes, number and outside diameter	256—2¼ in.
Tubes, length	17 ft.
Heating surface, tubes	2,550 sq. ft.
Heating surface, firebox	185 sq. ft.
Heating surface, tubes	2,735 sq. ft.
Grate area	34.8 sq. ft.
Smokestack, height above rail	14 ft. 11 in.
Centre of boiler above rail	8 ft. 11 in.

TENDER.

Tank	U shape
Frame	10 in. chan.
Wheels, diameter	33 in.
Journals, diameter and length	5 x 9 in.
Water capacity	5,500 gals.
Coal capacity	9.5 tons

COALING ARRANGEMENTS AT ROUNDHOUSES.

The coal pocket should be located so that engines can take coal inbound or outbound, as on modern engines the flues must be cleaned from the firebox end, and this cannot well be done when the tender is full of coal. A locomotive with modern front end appliances is so arranged that it is impossible to clean out stopped-up flues from the front without removing the draught appliances, and these in many cases have to be so carefully arranged that it is expensive, and many chances are run in getting them back just right, so as to insure the engine steaming; it has been found that on wide firebox engines, with the best arrangements of front end, stopped-up flues must be cleaned from the back end.

If from ten to twenty tubes are stopped up (and this is not exaggerated), it means that the heating surface of the engine is diminished by about 150 square feet, and this has a very material effect on the steaming of the engine, especially as the stopped-up flues are very likely to be at the bottom of the boiler, where the water is coldest.

A terminal that is so arranged that an engine must take its coal inbound, or block traffic if taking it outbound, is not arranged to give the best and most economical service, because, for the reasons given above, it is important that the tenders be clear of coal when the engine comes into the house, for the double purpose of first permitting the flues to be blown out, and second, that the tank may be lightly loaded and thus easier handled in case work is to be done on either the tender, its frame, or the trucks.—*R. D. Smith before the New England Railroad Club.*

THE PROBLEM OF TO-DAY is not only to develop the inanimate mechanical forces, methods and materials, many of which have been, and all of which may be, standardized, but to study, select, train and manage the animate human element, which cannot be standardized, and is the potent and controlling factor in the man-machine unit.—*J. E. Muhlfeld, New York Railroad Club.*

WHAT IS STEAM?—What would you give, off-hand, as the definition of steam? Is it a simple element to define? At an examination of firemen for promotion, held by one of the roads in Texas recently, this question was put to a fireman: "What is steam?" He hesitated for a moment and then replied: "Steam is water gone crazy with heat." He was promoted.—*Railway Journal.*

HANDLING LOCOMOTIVE SUPPLIES*

BY E. FISH ENSIE.

PART III.—STANDARDIZATION.

Introductory.—In the January, 1908, issue of this journal (page 7), the writer gave a general outline of the whole problem of handling and maintaining locomotive tool and supply equipments from its several aspects; for example, costs involved, minimum expectable expenditures, variations in cost on different roads and with different degrees of supervision, the primary Interstate Commerce Commission prescribed accounts covering all the expenditures involved, handling requisitions, standardizing equipment, checking for equipment, caring for and repairing equipments, with a summary of the results to be expected.

In the March, 1908 issue (page 90), the accounting and detailed costs were dealt with at some length, sufficient perhaps to give any mechanical transportation or accounting officer material for effectively applying the necessary basic accounting measures to secure full and reliable data for intelligent supervision of this item of expense.

It is the writer's purpose to conclude this series of articles with a chapter dealing with the standardization of the various articles constituting the locomotive equipments, and with the inspecting system by which alone the complete results as to low costs (the words "maintenance cost" would be misleading, as the I. C. C. charges are under the Transportation Accounts, and not under the Maintenance Accounts) can be secured.

OBJECTS OF STANDARDIZATION.

Standardization is a two-fold process: it determines in a general way what articles shall constitute a locomotive equipment, considering the purposes for which the equipment is needed, whether the need is real, whether it may be fulfilled in some other way, or by some substitution; and it specifies in minute detail as to design and quality, the construction of each item or article.

The objects of standardization are:

To give the best practical service of each article, and of the equipment as a whole; in other words, to bring the efficiency of the equipment to the highest point.

To give equipment so well designed, and so durable that it will last the longest per dollar expended, and not require the trouble and care of replacement, thus providing the greatest economy consistent with the greatest efficiency in the use of the supplies and equipments.

To promote the lowest yearly costs for the totals of each item used.

To reduce to a minimum the amount of equipment on an engine and hence the trouble of taking care of it as well as the first investment cost.

To set such uniform standards and specifications for all articles that there will not be confusion and variation in the ordering, and that purchases in large quantities at best quotations may be arranged for.

And to have such a uniform arrangement of the equipment on all engines, that inspection and care may involve the least amount of labor, and that records and supervision will be reduced to the greatest simplicity.

An outline will here be given of the method of such standardization, illustrating in detail a few of the articles thus standardized.

The locomotive of the olden time was fortunate in having its individual captain and attendant; the personalities of the engineer and fireman were wrapped up with the individual peculiarities of the locomotive, and the one responded to the sympathetic and skilful handling of the others. The engineer was largely his own mechanic, and when the locomotive went to the shop he laid off, too, and saw that a good job was done on his engine. His oil cans, hammers, wrenches and other tools and appliances also partook of his individual idiosyncrasies; in fact, he probably bought most of these from his own pocket money, just as the average machinist of to-day buys his own rule and calipers. The engines were small, the parts were light, and the engineer was able to effect emergency repairs with his tools on the road, or at a turning point off on a small branch line. He was a machinist as well as an engineer.

The pooled locomotive service, resulting from the use of heavier and more expensive units of motive power, has quite changed this situation, yet we find that the average locomotive equipment list of to-day savors of the character of a traveling machine shop, rather than of that of a set of appliances for the mere purpose of getting an engine over the road. Some articles are archaic, and serve a by-gone usefulness; others are duplications of articles carried elsewhere in the train; and still others were best left behind in the roundhouse or shop. The ax and saw have in modern days become an anachronism on a locomotive like the polished brass bands about the boiler jackets, and the luxuriant landscape views on the tenders, of former days. Extra air and signal hose are usually carried attached to the train and signal lines at the forward end of the locomotive, and may be detached from this position, where they are seldom used, in case of mishap to the hose and couplings at the tender end; jacks, bars and wrecking chains may be usually found as part of the equipment of a baggage car or a caboose car, and often only serve to be in the way and to get in uselessly bad condition when carried on the locomotive tender and mixed up with the coal. Sledges, soft hammers, various sizes of screw and pipe wrenches, keys, cotters, and other like parts, exhaust nozzles, and spare bells and whistles, had better remain in the tool room, or in the stock room, than to be carried around for some remotely (im)possible exigency on the road.

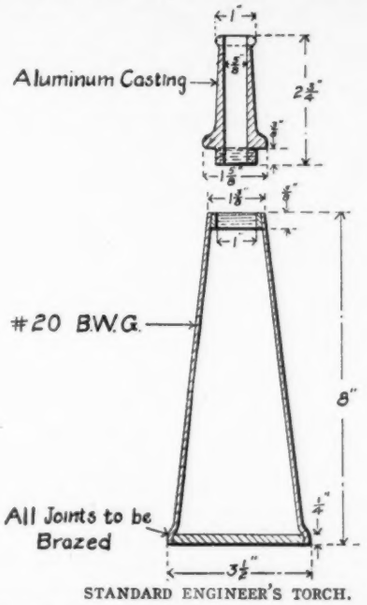
STANDARD ARTICLES.

A list of standard equipment which will fulfil satisfactorily the average needs on American railways, with of course some changes here or there to fit particular circumstances, is given herewith. It would be beyond the space permitted in this paper to give detailed specifications, drawings, photographs, prices, and names of manufacturers, of each item of this standard equipment, and a few typical instances only will be chosen to illustrate the way in which standardization is handled.

The first case chosen will be that of the engineer's torch, because it combines the functions of several different kinds of equipment (namely, of tool, of lamp, of oil receptacle, and of an indispensable article). The function of the torch is primarily to give light to the engineer when oiling around, both outside and inside the frame; the torch should not be too heavy to hold, nor too bulky; it should stand up solidly, or lie down without leaking or going out; it should be of such proportion as to have its light easily thrust into restricted quarters; and it should be durable, and of such distinctive design that shopmen may not appropriate it without detection; it should burn well, and hold sufficient, but not too much oil. When engineers had their torches specially made, they used to be made of polished brass tubing, fitted with a large screw cap at the bottom, or possibly an end piece soldered fast, and a screw top with wick nipple

* Continued from page 95 of the March, 1908, issue.

at the other end, for holding the torch wicking. These torches were quite expensive, but the engineers took great pride in them, often keeping them highly polished, and jealously guarding them as their personal property for many years. At the present time the torch is either a tin pot torch, of the teapot pattern, or a malleable iron pot or hand torch (the latter of similar dimensions to the old-time brass torch), or more rarely a sheet iron



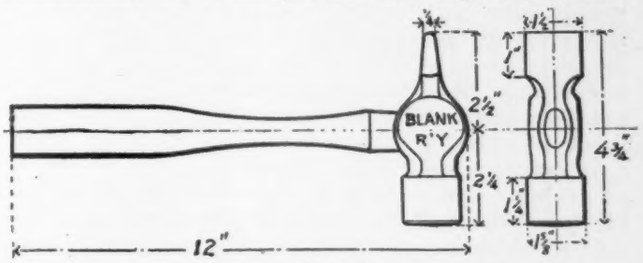
STANDARD ENGINEER'S TORCH.

torch of a lighter, more handy, and more durable construction. The objection to the old-time brass torch was, of course, in its cost to make, though, if well taken care of, there is no question but that the brass torch at $2.00 or $3.00 each, is more economical than some of the cheaper torches that are bought to-day, as they will last years, where the others do not last weeks. But it is of course true that if the equipment is not carefully looked after the indiscriminate and wasteful use and abuse of brass torches will prove a great extravagance. Lack of care and restraint in the use of property always results in wasteful extravagance.

The tin pot torch largely in use to-day, although suitable for shop use, is altogether unfitted for the rigors of service out on the road. The seams become unsoldered, the torch upsets and leaks, it is crushed, dented, and handle and spout broken off; the oil cap is lost, the spout cannot be thrust far in between the motion work of an engine in close quarters; and it is light and upsets easily. The average life of such a torch, even under good practice and care, and taking advantage of the resoldering and re-using of second-hand torches, is less than two months; and the average cost is over 25 cents for even the cheapest grade of the article that will give service at all. Compare this with the more efficient, serviceable and satisfactory brass torch, that will cost ten times as much, but last twenty times as long, with the same proportionate amount of care and attention.

The malleable iron torch is a very durable affair, and some examples of it, especially in the hand torch, are very well designed. These torches are much handier to use than the pot torches, but in practice they are found to have the following disadvantages: they are so heavy that the engineer finds them difficult to handle, becomes disgusted with them, gets rid of them at the first opportunity, and prefers even the much less suitable tin torch, because of its lightness; the malleable iron torch in the hand form will not stand up well, and when it lies down it almost always leaks—in practice, that is; but for these disadvantages the malleable iron hand torch would be almost ideal for use. It costs but slightly more than the tin torch.

Several supply firms handle a form of sheet iron torch, with a brazed seam, substantial bottom, attenuated shape, and efficient wick nipple. A design is here shown that represents the best features of the best of these torches, but that is not the product of any particular supply company. Its construction may be briefly described: the main body of the torch is a piece of sheet metal (iron, brass, or even aluminum), formed in the shape of a cone, brazed together substantially at the seam, flanged at the base, brazed to a ¼-in. iron bottom of sufficiently wide proportions to make the torch stable, and tapering to about an inch and a half in diameter at the upper end. An aluminum, or a very light steel nipple, of considerable length, is used for the wick, and screws into a ring that is brazed inside of the upper taper end. This torch will sit up, because it has a concentrated weight at the bottom; it is of a simple, durable, strong and substantial

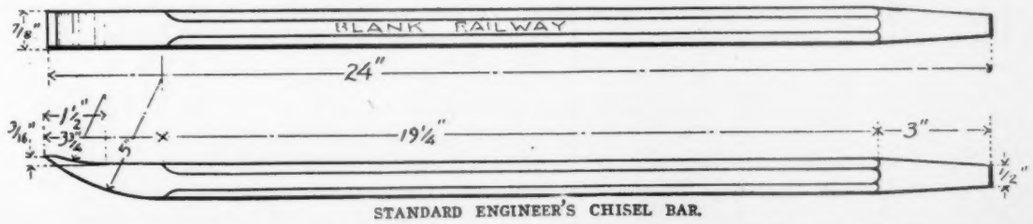


STANDARD ENGINEER'S HAMMER.

construction; it will not leak; it is light and handy in use; and it can be thrust into the narrowest quarters. Its cost very little, if at all, exceeds that of the cheaper torch just quoted, yet a much smaller number are required to be supplied to engines each year.

An example has been quoted of a large railway that used a new torch on an average of each week to ten days for each engine in service; the standards on this railway were the malleable iron hand, and tin pot torches. Hammers, used by the engineers, which cost about the same price, were not used up nearly so fast. The extraordinary consumption of these torches was due, not so much to general carelessness of enginemen, as to the carelessness resulting from their disgust with unsatisfactory articles.

We shall next consider a standard hammer. This hammer should be designed for use by engineer on the road. An ordinary machinist's or boilermaker's hammer will not do. The machinist's hammer is too light, the handle is too long for the work in contracted quarters under an engine, and the design, being identical with that of the shopman's hammer, offers a needless temptation to roundhouse men and others to purloin these from the engine. Moreover, the ball pein is of no use practically to an engineer. An engineer's hammer should weigh about two pounds, so that he can strike an effective blow with it to knock out a pin or bolt, should have a handle about twelve inches long, and should be equipped with a wedge pein so that it may be used in lifting the lids of cellar boxes, and to distinguish it completely from the shopmen's hammer. A hammer fulfilling these conditions, which may be economically made of malleable iron, is shown in the illustration.



STANDARD ENGINEER'S CHISEL BAR.

The chisel, too, ought to be radically different and distinguishable from the shopmen's tools, and for this reason should be made of hexagon, instead of octagon steel. The flat chisel is all that is required in this direction on a locomotive, as a cape

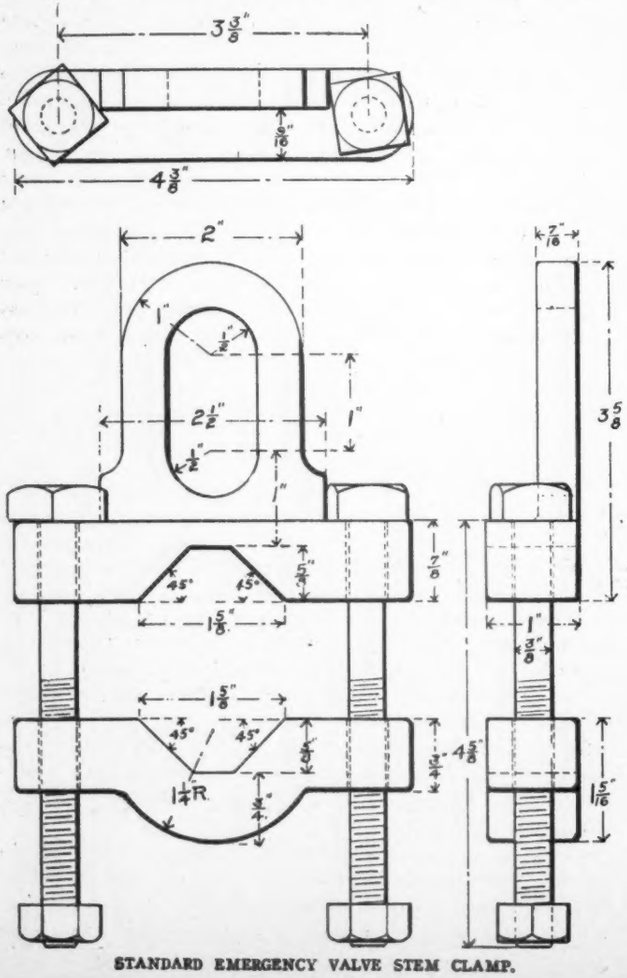
chisel, or round-nose, are of little use in the hands of an engineer of to-day, who is not a machinist in a specialized sense. This chisel serves also as a set, or as a wedge.

Next is shown a small chisel bar, which serves the purpose of bar, of cold chisel, and of jack lever, where a jack is carried. As this article has no duplicate in the shop, it can be made of the customary octagon steel.

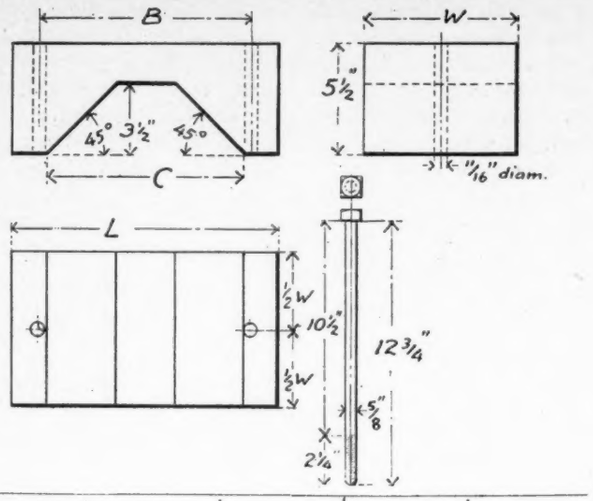
It is sometimes advocated that it is economy to use up on the locomotives all the old brooms that have served one period of usefulness already in the various offices, stations, shops, and elsewhere on the railroad. This idea is all right, but it does not go far enough. There are not nearly enough brooms to go around, as one broom is consumed per locomotive every two to six weeks. This case is not like that of the torches, due to indifference, and flagrant carelessness, but is due to legitimate wear in actual sweeping service, and is unavoidable, so long as brooms are used. To a limited extent, the second-hand brooms can and should be used, but it will be found that they will not supply more than from three to twelve per cent. of the locomotive needs, and will then of course not last as long as new brooms. It is true that a short and stubbly broom is more suited for use on an engine than a nice long resilient house broom. A special design of broom embodying the characteristics needed for locomotive use, and wearing from two to three times as long as the average finer broom can be made, the first cost being practically the same.

The next article, an emergency valve stem clamp, normally carried bolted on the valve stem, should be on every engine, and the design shown will fit almost every locomotive valve stem in existence, the screw lengths on the bolts permitting of this wide variation in size. The upper loop of the clamp, is of course attached under the gland nut. This is a very useful and convenient article in case the engine has to be disconnected.

Another emergency article is the crank-pin block. These blocks are often made to closely fit the crank pin of the particular engine to which they are to be applied, being nicely sawed round for this purpose. This care in fitting is unnecessary. Usually



STANDARD EMERGENCY VALVE STEM CLAMP.



Size	B	C	L	W
1	11⅞	10	13	7¾
2	7⅜	7⅛	10	5⅝
3	5⅝	5¾	8¼	4⅛

STANDARD CRANK-PIN BLOCK.

two or three sizes will take care of all classes of engines, these sizes being determined by the length of pin, a half-inch play being permissible. The diameters of the openings need only be such as will permit of the crank pin collar holding the block in place. One standard size bolt serves all blocks. Great economy in manufacture and in stock carried is attained by these standard blocks. Cross-head blocks may be reduced to similarly few standard sizes.

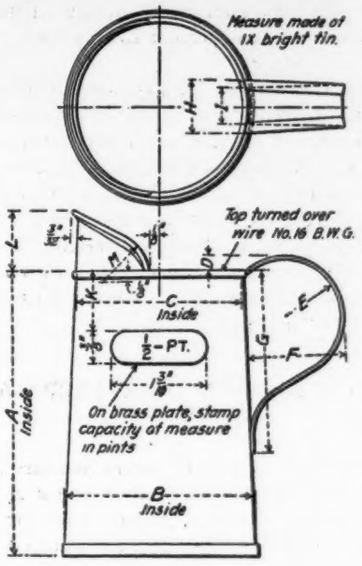
In discussing standard articles of equipment connected with handling locomotive supplies, mention should be made of the importance of having standard measuring cups at the oil houses, so that the oil allowances may be accurately given out. By the working out of this plan under the direction of one of the most progressive motive power men in this country, it was found that many thousands of dollars were saved annually by the deterrent thus provided against excessive oil issues. A standard design of can is here shown, together with full dimensions.

Standard List.

The accompanying list is nearly complete as regards the necessary movable equipment carried on a locomotive. The writer would welcome any comments, amendments, changes, additions or subtractions that readers may be interested enough to offer. Articles prefixed by an "S" should be reduced to one standard for all engines where used. Those marked "X" may be used according to special characteristics of the service or at the discretion of the officials of each road considering the proposition.

Standard for all engines in every class of service:

X 1	Medical box	S 1	Long engine oiler
S 1	2 lb. wedge pein hammer	S 1	Valve oiler
S 1	21" screw wrench	S 1	Emergency knuckle
S 1	12" screw wrench	2	Seat cushions
S 1	Grease cup wrench	2	Back cushions
1	Double end set screw wrench	2	Arm rests
1	Air pump spanner wrench	X 1	Back curtain
S 1	Flat chisel	X 2	Side curtains
S 1	Valve stem clamp	X 3	Lubricator glass tubes where used
S 1	Red lantern		
S 1	White lantern	X 2	Water glasses where used
S 2	Classification lamps	X	Guards for above
S 1	Steam gauge lamp	1	Oil can box
S 1	Water gauge lamp	2	Clothes boxes
1	Headlight case and reflector	S 2	Clothes hooks
S 1	Water cooler	S X 1	Key hook
S 2	Drinking cups	S 1	Small tool box
S 1	Tank bucket	S 1	Supply box
S 1	Broom	S 1	Large emergency tool box
1	Set of flag staffs and flags, as prescribed by operating rules	S 1	Set of instructions for handling lubricator, air brake, fuel, supplies and tools, reporting boiler troubles, handling injectors, reporting engine troubles, and electric or acetylene headlight, operating rules, handling compound locomotive, and superheater locomotive, handling oil burning locomotive
X 4	Short hot box hose		
S 1	Sprinkler hose		
1	Bell cord (preferably cotton)		
S 1	Torch		
S 1	2 gal. valve oil can		
S 1	2 gal. engine oil can		
S 1	1 gal. headlight oil can		
S 1	1 gal. signal oil can		
2	Complete sets spare wicks for each lamp and lantern	X 2	Flue plugs
S 1	Extra white lantern globe	S X 1	Compound bucket, where needed
1	Set of slides, as required by operating rules for classification lamp (colored glass)	X 2	Plugs for cylinder relief valve



Line No.	Size in Pints	A	B	C	D	E	F	G	H	I	K	L	M
1	1/8	2 3/16"	1 9/16"	1 5/16"	1/8"	5/8"	1"	1 3/4"	1/2"	1/4"	1/2"	...	..
2	1/4	2 7/4	1 15/16	1 11/16	3/16	3/4	1 1/4	2 1/4	5/8	3/8	3/4	...	...
3	7/16	3 3/8	2 11/32	2	3/16	3/4	1 1/4	2 1/4	5/8	3/8	3/4	...	...
4	1/2	3 1/2	2 7/16	2 3/32	3/16	3/4	1 1/4	2 1/4	5/8	3/8	3/4	3/4"	5/8"
5	3/4	4	2 13/16	2 13/32	3/16	3/4	1 1/4	2 1/4	5/8	3/8	3/4	13/16	3/4
6	1	4 3/8	3 3/32	2 5/8	1/4	1	1 3/4	3	1	1/2	1	15/16	13/16
7	1 1/4	4 3/4	3 6/16	2 27/32	1/4	1	1 3/4	3	1	1/2	1	1	7/8
8	1 1/2	5 1/16	3 17/32	3 1/32	1/4	1	1 3/4	3	1	1/2	1	1 1/16	15/16
9	2	5 9/16	3 7/8	3 11/32	1/4	1	1 3/4	3	1	1/2	1	1 3/16	1
10	2 1/2	5 15/16	4 3/16	3 5/8	1/4	1	1 3/4	3	1	1/2	1	1 1/4	1 1/16
11	3	6 5/16	4 7/16	3 13/16	1/4	1	1 3/4	3	1	1/2	1	1 5/16	1 1/8
12	4	6 15/16	4 7/8	4 7/32	5/16	1 1/2	2 1/2	4 1/2	1 1/4	3/4	1 1/2	1 7/16	1 1/4
13	5	7 1/2	5 9/32	4 1/2	5/16	1 1/2	2 1/2	4 1/2	1 1/4	3/4	1 1/2	1 9/16	1 3/8
14	6	8	5 19/32	4 13/16	5/16	1 1/2	2 1/2	4 1/2	1 1/4	3/4	1 1/2	1 11/16	1 7/16

STANDARD OIL MEASURING CUP.

In addition to above, all road engines:

S 1	Long oiler	S 6	Torpedoes
X 1	Recorder	6	Fusees
S 1	Torch	S 1	Packing hook
1	Wrecking wedge	S 1	Packing spoon
S 1	Pinch bar	S 1	Chisel bar
2	Guide blocks	S X 1	Extra steam heat hose
2	Crank pin blocks	S X 1	Extra mica headlight chimney, or
1	Engine truck brass		
2	Tank brasses	S X 6	Extra carbons, and
S 1	Red lantern globe	S X 1	Extra electrode, or
	Extra flags and staffs, as required by operating rules	S X 1	Extra acetylene tip
		S 1	Time card holder

Coal burners only:

S 2	Coal scoops (1 second-hand)	1	Ash hoe
1	Fire hook	1	Grate shaker bar
S 1	Coal pick		

Oil burners only:

1	Tank oil gage	S 1	Engine cab sand box for sanding flues
1	Carbon bar		
S 1	Sand funnel (built in fire door)		

Yard engines only:

S 1	Push pole	X	Fire extinguishing apparatus
S 2	Re-railing frogs		

CHECKING LIST.

These articles should be listed upon a convenient manila card form arranged in such a way as to furnish a ready means of checking by the tool checker or inspector at terminals. If the standard tools are placed according to a standard arrangement in the standard cab and tank boxes, and the list is made up so as to follow a natural and convenient order for inspecting the various articles, it is the work of but from two to six minutes to completely inspect the equipment of an engine. With a well-worked-out arrangement of this kind, the cost of inspection and supervision is reduced to a minimum.

The list may better be checked by the items found missing than by those found intact, and the checking may be done either with pencil and carbon copy, or preferably by punch or pinhole. A copy should be retained by the checker; one sent to the master mechanic in charge of the engine, and with some comment or explanation as to missing articles; and one sent to the equipment or supply supervisor responsible for the efficient handling of these supplies and tools. From these sheets valuable records of the habits of the various engine crews may be compiled.

It has been often suggested that tools and other articles may best be guarded on the engines to which issued, if they bear the stamp of the engine number to which originally issued. Simple as such a plan would seem to be, it is found open to many objections in practice. Stencils must be kept at every store or supply house; there is delay in issuing; the number stamps must be such as to be proof against easy alteration, abrasion, or counterfeiting. It is difficult to stamp oil cans and some other articles, such as red lantern globes or wrecking frogs. Articles may become mislaid or duplicated when engines are shopped. What is one to do when a duplicate number is issued and the original turns up? On the whole, it will be found best to avoid this degree of refinement in keeping track of equipment—at least, until a system of checking and looking after the tools and articles in question has been very thoroughly worked out, and has already reached a high state of efficiency and economy. Then it will be time enough to consider whether the extra cost of numbering all articles, and keeping track of them interminably will be worth while in view of the further savings practicable.

RELIABILITY OF COMPARATIVE ACCOUNTS OF COSTS.

In connection with this whole matter of checking and accounting for the engine equipments it has been suggested, since the chapter in the March, 1908, issue on "Accounting," that reliable comparisons are not to be had in view of the wide diversity of practice in accounting for these articles; and that such comparisons are especially meaningless with the still greater diversity of past years in accounting practice. The suggestion is perhaps well taken, although full consideration may not be given to the weight or value of each of the elements entering into the charges for equipment and supplies. A careful examination of the accounts on pages 90-92 of the March issue will make clear beyond almost any reasonable doubt where the various charges for the various items making up an engine equipment *should* go according to the only legal and prescribed classification of accounts promulgated by the Interstate Commerce Commission. To make the matter still clearer, I am adding another list apportioning various classes of articles in respect of their proper accounts.

According to the Interstate Commerce classification of operating expenses, the following items, attachments to the engine, should be charged to the cost of repairs:

Flag brackets
Classification and marker lamp brackets
Gauge lamp brackets
Headlight bracket
Boxes
Coal boards
Fire door chains
Grease cups
Gauge cock drip trough
Permanent piping for hot tender boxes
Hooks
Front and back coupler knuckles in place
Air signal hose, front and back, in place
Air hose, front and back, in place
Steam heat hose, back, in place
Water hose between engine and tender
Oil hose between engine and tender
Lubricator
Tank scoop (water scoop)
Cab windows
Electric cab block signals
Recorder
Built-in-sand funnel
Whistle lever
Bell
Bell ringer
Gongs

The following articles also should be charged to the account, "Repairs to Locomotives":

Arm rests and cab cushions
Cab curtains and awnings
Crosshead blocks
Guide blocks
Flue plugs
Valve stem clamps
Headlight
Cab lamps
Classification lamps
Extra signal, brake or steam hose
Extra brasses
Extra rod packing
Emergency knuckles

The following items, although attachments, should be charged to the accounts covering other supplies to yard and road locomotives:

Guard for water and lubricator glasses
Bell cord, extra only
Grate shakers
Squirt hose
Hot box hose connection
Hose reels
Fire hose
Switch chains
Switch ropes
Switch poles
Thawout hose
Water coolers

Locomotive operating tools:

Ash hose
Ash pan rods
Clinker hooks
Graphite can
Packing hooks
Packing spoons
Picks
Pokers
Scoops
Shovels
Slash bars

Oiling tools:

Oilers
Long oilers
Tallow pot
Grease cup wrench
Packing hooks
Packing spoons

Locomotive adjustment and repairing tools:

Buggy and chisel bars
Chisels
Crowbars
Drifts
Files
Hammers
Pinch bars
Plugging bars
Punches
Scrapers
Sledges
Sets
Wrenches

Emergency tools:

Axes
Hand saws
Hatchets
Jacks
Jack screws
Saws
Pinch bars
Wrecking frogs
Switch chains
Medical box

Locomotive cleaning appliances:

Brooms
Brushes
Buckets
Soap
Tripoli
Pans for soap and lather
Sponge
Sponge holder
Front end scrapers
Headlight reflector chamoix

Signalling apparatus:

Headlight chimneys
Flags and flag staffs
Classification lamps and slides
Lanterns and parts
Torpedoes
Fusees
Bell cord

Consumable stores:

Headlight oil
Signal oil
Wicking
Graphite
Soap
Putz
Matches
Sand

For carrying tools and supplies:

Portable boxes
Oil supply cans
Match case
Soap box
Tripoli can

Lubricants for locomotives: Accounts 77 and 86.

Valve oil
Engine oil
Car oil
Grease
Dope
Waste
Lubricating compounds

Examination of the tables of "Approximate Apportionment of Detail Expenses" shown on page 92 of the March issue will show still further just definitely where each class of expenses in connection with handling locomotive supplies and tool equipments, belongs, and the approximate proportion of each to the whole. These tables, which are a thorough analysis of the charges in question, show that even including all kinds of charges to accounts other than those prescribed by the I. C. C., for "Other Supplies for Locomotives," such as tool checkers, supervision, accounting, stationery, inspector's traveling expenses, hostlers on this work, etc., etc., the total of all charges of this nature should not exceed $77.50 per locomotive per year in any case, and should reasonably fall to $35 per engine per year with proper supervision and systematic handling. At the latter rate a road owning 1,000 locomotives should cost all told from $35,000 to $77,500 a year for all expenses connected with locomotive supplies and equipments, only some $18,500 to $37,000 of which properly belong under the accounts prescribed for these expenditures; if the road owned some 1,400 locomotives, the total cost should in no case exceed $107,500, especially if it were an eastern road, and if the expense according to the prescribed account alone were more than this, such excess would be a certain indication of avoidable waste which by reasonable attention and economy ought to be saved. As a matter of fact, in the latter hypothetical case, an additional $60,000 should also be cut off the annual expenditure.

In conclusion it should be stated that all the methods, forms and standards indicated in this series of papers are taken from practice, and represent practical and not theoretical propositions. In no sense are the economies sought and attained a paper showing—a mere shifting of accounts. It used to be that any one with sufficient ingenuity could "make a showing" by shifting burdensome changes to accounts not connected with the activities concerned in the "showing." But now such a course would be illegal, and future comparisons of railroad statistics will be more reliable than they have been.

A CHICAGO PLAN FOR JOINT SHOP AND SCHOOL WORK

According to the *Iron Age* Chicago machinery manufacturers and the Lewis Institute are co-operating in a plan of joint shop and school instruction for boys, somewhat similar to that which has been carried out by Cincinnati manufacturers and the University of Cincinnati for several years. A modification of the plan has also been in operation at Fitchburg, Mass., since the fall of 1908, though in the latter the school does not have any shop equipment. The Chicago arrangement, after a short period of experiment, has recently been put in effect. Under it the manufacturers send their apprentices to school at the institute half the time, one week being spent in the shop and the next week in the school. The course extends over two years, but it is not the idea of the manufacturers or of the instructors at the Lewis Institute that a boy can become a skilled workman in that time. The expectation is that he will get a more intelligent grasp of his trade than he could otherwise obtain. The age limits are 16 and 20 years. Each manufacturer may be represented in the school by a unit, or two boys, or by two units—four boys. The employer pays the tuition fee of $50 a year for each pupil and pays the boy $5 for each week he works in the shop. In this way the boy receives his instruction free and $2.50 a week for two years. Two weeks' school vacation are given in the summer, but 26 weeks a year are spent in the shop.

The Lewis Institute will give instruction to the boys eight hours a day five days in the week. Two hours a day will be spent on each of the following lines of study: 1. Physical science and the principles of mechanics. 2. Mechanical drawing. 3. Shop work, supplementing that done in the metal working establishments. 4. English, history and mathematics. Twenty-seven boys are now taking the metal working course in the institute, and some of them are sufficiently advanced to be sent to shops at once. Several boys serving apprenticeships in shops are being tried out, and will probably prove good enough to be sent to the institute. The boy who puts in the full course at the institute will still have to learn his trade, though the term of his apprenticeship may be reduced as a result of his better education. The Lewis Institute has equipment for the instruction of 60 boys in the course provided in the metal trades.

WINDOWS IN ROUNDHOUSES.—One of the engine house details which is constantly in sight are the windows. These get dirty very easily and are a constant expense to keep clean. With the usual construction involving a high wall to let in lots of light, it is often necessary to clean the upper sash by ladders or long-handled brushes. A scheme which has been found very satisfactory is an arrangement of four sash in a single frame, the top one balanced against the lower and the two intermediate ones balanced against each other. This does away with sash weights, and any sash may be pulled down to the window sill level and the glass easily and cheaply cleaned. It also has the advantage of giving a clear opening of 75 per cent. of the frame area in summer time. A 12-inch I beam makes a very good frame as it never rots out and is stiff and rigid. Short sections of the parting strips are removable at the bottom so the sash can easily be slipped in and hung.—*Wm. Elmer, before the Railway Club of Pittsburg.*

DATA OF SPECIAL INTEREST TO THE DRAFTING ROOM

SEMI-ELLIPTIC SPRINGS.

(From the American Locomotive Company's Standard Practice.)

CALCULATIONS.

In obtaining the net static load, the actual weights of the parts constituting dead load, such as wheels, axles, boxes, etc., should be deducted instead of taking a certain arbitrary percentage.

Maximum fibre stress allowable, 80,000 pounds. The figures given on Spring Card in "Load" column are the calculated loads which springs will carry at 80,000 pounds fibre stress and are the maximum loads for which springs should be used.

It is advisable usually to make the capacity of springs slightly more than the net actual load, as given below.

REQUIRED CAPACITY.

DRIVING AND ENGINE TRUCK SPRINGS: Use calculated static load plus 500 to 1,000 pounds, or about 5 per cent.

UNDERHUNG DRIVING SPRINGS: For passenger engines use calculated static load plus 20 per cent.

TRAILING SPRINGS: Use calculated static load plus 15 per cent.

TENDER SPRINGS: Use calculated static load taken with maximum load of coal and water.

The spring tables for semi-elliptic springs give the capacity of one plate one inch wide and different thicknesses.

To obtain the required number of plates, multiply the figure given in "Load" column by the width of spring in inches and divide the required capacity by the result. The quotient gives the number of plates required. Where quotient gives decimal more than 3 add one plate to the whole number.

The number of full length plates must be 25 per cent. of the whole number required. The last full length plate must be tapered at ends and the remaining plates must be regularly shortened and tapered. The length of the shortest plate must not be less than twice the length of the spring band.

The deflection given in table is the difference between free and loaded height, irrespective of width or number of plates; for full-elliptics the number of plates and deflection given is for each half of spring.

(From an article by William H. Mussey, American Engineer & Railroad Journal, June 1906, page 233.)

Careful tests made in actual service showed that the greatest value for a live load on a locomotive driving spring was about 65 per cent. above the static working load, and the minimum was 45 per cent. less than the static working load.

Reauleaux formula for semi-elliptical springs is as follows:

SPRING TABLES.

SEMI-ELLIPTIC SPRINGS.

LENGTH BETWEEN CENTERS	ONE PLATE 1" WIDE.									
	¼" PLATE		5/16" PLATE		⅜" PLATE		7/16" PLATE		½" PLATE	
	LOAD	DEFLECTION	LOAD	DEFLECTION	LOAD	DEFLECTION	LOAD	DEFLECTION	LOAD	DEFLECTION
20	167	.98	260	.78						
22	152	1.19	235	.95	341	.79				
24	139	1.41	217	1.13	312	.94				
26	128	1.66	200	1.32	288	1.10	393	.95		
28	119	1.92	186	1.53	268	1.28	365	1.10		
30	111	2.20	173	1.76	250	1.47	341	1.26		
32			163	2.00	234	1.67	319	1.43		
34			153	2.26	220	1.88	301	1.62		
36			144	2.53	208	2.12	284	1.81	372	1.58
38					197	2.35	269	2.03	350	1.76
40	FORMULAE USED IN COMPUTING TABLE				187	2.60	255	2.24	333	1.95
42					178	2.87	243	2.47	317	2.16
44	$P=\frac{53333\ H^3}{L}$				170	3.15	232	2.71	303	2.37
46					163	3.45	222	2.96	290	2.58
48	$F=.000611\ \frac{L^2}{H}$				156	3.75	213	3.22	277	2.82
50							204	3.49	266	3.06
52	P=net static load						197	3.78	256	3.30
54	F=deflection						189	4.08	247	3.57
56	H=thickness of plate								238	3.83
58	L=length between centers								230	4.12

AMERICAN LOCOMOTIVE COMPANY'S STANDARD PRACTICE CARD.

$$P = \frac{Snbh^2}{6L}$$

P = Static load on one end.
L = ½ span in inches less ¼ width of band.
S = Fibre stress per square inch.
b = Width of plate in inches.
h = Thickness of plate in inches.
n = number of plates.

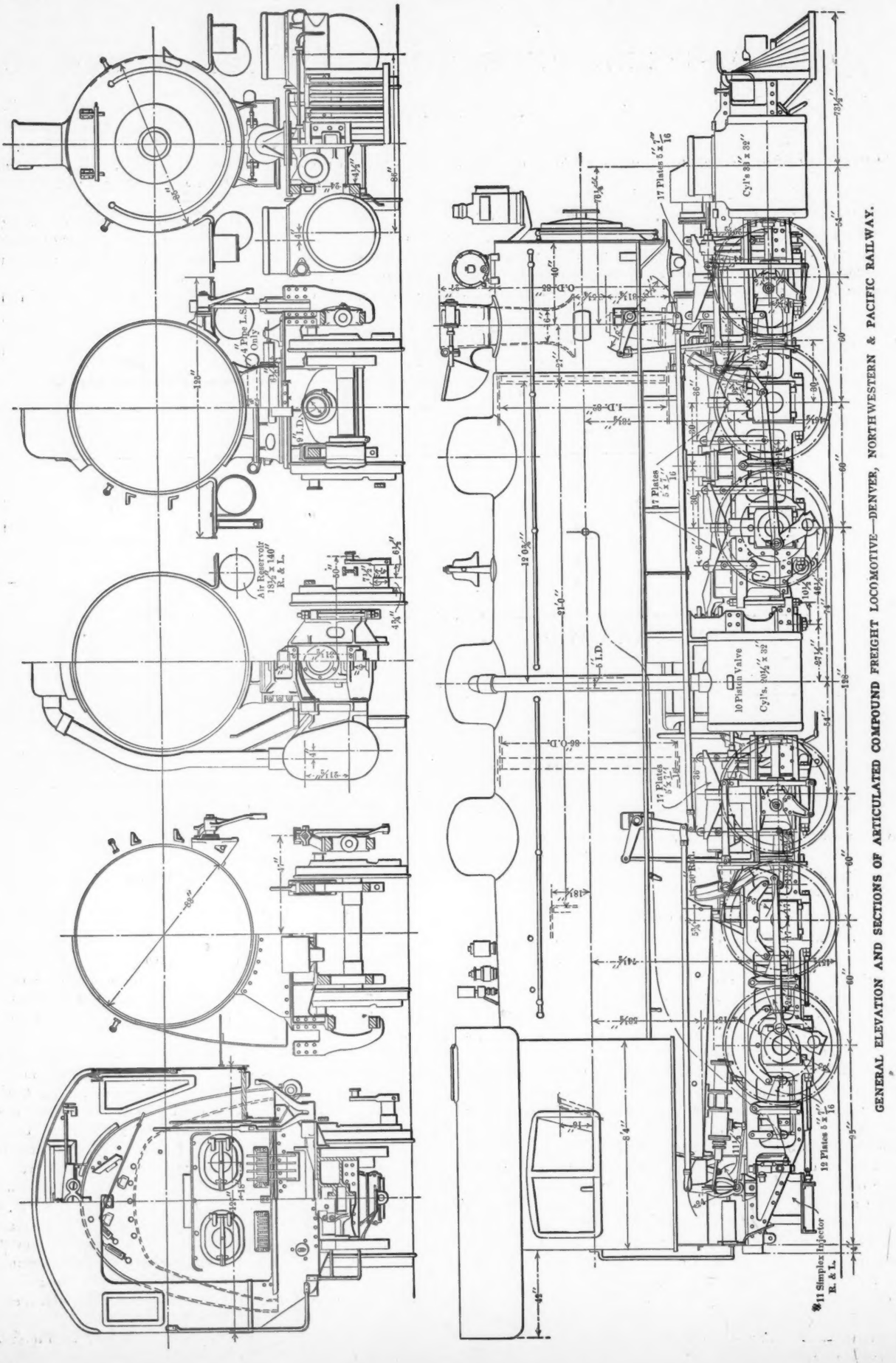
$$D \text{ (deflection)} = \frac{SL^2}{Eh^2}$$

E = Modulus of elasticity = 29,400,000.

There may be some question about the deduction from L of one-quarter the width of the band, but this is theoretically correct, as a study of the action of the leaves of the spring will show.

Where possible short springs should be avoided and also narrow ones. Long springs with wide plates give the most even deflections, taking up shocks most effectively. Springs equalized together should have equal deflections under the same working loads as far as possible. An example is given in the case of a spring with a span of 26 in. and 3/8 in. leaves which was equalized with a spring having a 38 in. span and 7/16 in. leaves. This short spring gave very poor service. However, by reducing the thickness of the plate, with still about the same fibre stress, much better results were obtained. The aim should be to increase the deflections for given loads on short springs and decrease them on long springs which are equalized together. The formula for deflections shows that it varies directly as the square of the length of span and inversely as the square of the thickness.

Canada requires passenger cars to be lighted by Pintsch gas, acetylene or electricity.



GENERAL ELEVATION AND SECTIONS OF ARTICULATED COMPOUND FREIGHT LOCOMOTIVE—DENVER, NORTHWESTERN & PACIFIC RAILWAY.

ARTICULATED COMPOUND LOCOMOTIVE 0-6-6-0 TYPE

DENVER, NORTHWESTERN & PACIFIC RAILWAY.

The American Locomotive Company has recently delivered to the Denver, Northwestern & Pacific Railway, generally known as the Moffatt road, a Mallet articulated compound locomotive, which is shown in the accompanying illustration. The topography of this road would seem to be particularly well adapted for the articulated type of locomotive, and judging by experience on other roads, under similar conditions, this will probably prove to be the forerunner of further equipment of the same kind.

The district in which these engines will be put in operation has a deep sag at Boulder, Colo., on either side of which there is a continuous grade for about 17 miles, which reaches a maximum of four per cent., the line being practically a continuous series of curves. Trains of 500 tons are now being operated in good weather by two and in bad weather by three consolidation locomotives. It is expected that this Mallet engine will alone handle these trains at a speed of about 12 miles per hour.

This locomotive is also to be experimented with in a service for which it would appear to have special advantages, *i. e.*, pushing a rotary snow plow. This region has very long winters, with very heavy snows, and the line is kept open only by the continuous use of rotaries.

The plows have heretofore been pushed by as many as five consolidation locomotives, and because of the large number of engines, which makes it difficult to control the starting and stopping as quickly as is desired, it is believed that the Mallet, capable as it is of exerting a very large tractive effort at slow speed and with its non-slipping ability, will prove to be a great success in this service.

The design in general follows very closely that used on the first locomotive of this type built in this country for an American railway, *i. e.*, the Baltimore & Ohio 0-6-6-0 type. There are, however, a number of small differences, as will be noticed by comparing the list of dimensions below with those used on the B. & O. locomotive, which were given in the table of dimensions published in the June, 1908, number of this journal.

The weight has been reduced from 334,500 to 327,500 lbs., a reduction of 7,000 lbs. Part of this was obtained by reducing the number of flues from 436 to 409 and the rest by the re-design of a number of the heavier parts. The size of the cylinders has been changed, the present engine having 20½ and 33 in. diameter cylinders in place of 20 and 32 in. The steam pressure has been reduced from 235 to 225 lbs. and the tractive effort increased to 73,900 lbs. The general arrangement of the boiler and machinery is shown in the illustration on the opposite page and the dimensions, weights and ratios are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Pushing
Fuel	Bit. Coal
Tractive effort	73,900 lbs.
Weight in working order	327,500 lbs.
Weight on drivers	327,500 lbs.
Weight of engine and tender in working order	487,300 lbs.
Wheel base, driving	10 ft. 10 in.
Wheel base, total	30 ft. 8 in.
Wheel base, engine and tender	64 ft. 4 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.43
Total weight ÷ tractive effort	4.43
Tractive effort x diam. drivers ÷ heating surface	773.00
Total heating surface ÷ grate area	72.60
Firebox heating surface ÷ total heating surface, per cent	3.90
Weight on drivers ÷ total heating surface	62.20
Total weight ÷ total heating surface	62.20
Volume equiv. simple cylinders	19.45
Total heating surface ÷ vol. equiv. cylinders	270.00
Grate area ÷ vol. equiv. cylinders	3.70

CYLINDERS.

Kind	Mellin Compound
Diameter	20½ and 33 in.
Stroke	32 in.

VALVES.

Kind, H. P.	10 in. Piston
Kind, L. P.	Allen-Porter Slide
Greatest travel H. P.	6 in.

MALLET ARTICULATED COMPOUND LOCOMOTIVE—DENVER, NORTHWESTERN & PACIFIC RY.

Greatest travel L. P.	6½ in.
Outside lap H. P.	1⅛ in.
Outside lap L. P.	1 in.
Inside clearance	¼ in.
Lead in full gear	3/16 in.
Gear, kind	Walschaert

WHEELS.

Driving, diameter over tires	55 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	9 x 13 in.

BOILER.

Style	Straight
Working pressure	225 lbs.
Outside diameter of first ring	84 in.
Firebox, length and width	108 & 90 in.
Firebox, plates, thickness	C—7/16, T—9/16, S & B—⅜ in.
Firebox, water space	F—5, S & B—4½ in.
Tubes, number and outside diameter	409—2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	5035 sq. ft.
Heating surface, firebox	206 sq. ft.
Heating surface, total	5241 sq. ft.
Grate area	72.2 sq. ft.
Smokestack, diameter	16½ in.
Smokestack, height above rail	15 ft. 9½ in.
Center of boiler above rail	120 in.

TENDER.

Tank	Waterbottom
Frame	A. L. Co. Standard
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9000 gals.
Coal capacity	12 tons

RAILWAY STOREKEEPERS' ASSOCIATION. The sixth annual meeting of the above association will be held in Chicago, May 17 to 19, inclusive, 1909. The headquarters will be at the Auditorium hotel.